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Some effects of Machiavellianism and change of leaders on group productivity.

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SOME EFFECTS OF MACHIAVELLIANISM AND CHANGE OF LEADERS ON GROUP PRODUCTIVITY

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CHAPTER I

THEORETICAL FOUNDATIONS

This chapter is primarily concerned with providing background and foundation material for the research which is to follow. The relationship between group decision making and various personality dimensions is examined. The nature of successful groups is studied; special attention being given to the composition of the group and the personalities of its constituent members. Uncertainty, a byproduct of change, is studied for its effect on the individual personality and subsequently on the behavior of the group. The purpose of this research is stated. Finally, some working definitions are given.

Origin of the study

Two problems common to most organizations and groups are environmental and internal change. Environmental change includes changes in technology, competitive market structure, legislation and all those external factors which claim the major portion of organization's task directed activities. Internal change is defined in terms of change of membership. Current literature of the effects of change cite environmental and internal change as the major deterrents to group productivity.[1]

Challenge of change

According to much popular literature the most serious challenge facing the organization today is the challenge of change. This change seems to be growing in its dynamics. It is change characterized by continued acceleration. As an example of such writing, Robert Oppenheimer describes change in the following manner

> "One thing that is new is the prevalence of newness, the changing scale and scope of change itself, so that the world alters as we walk on it, so that the years of a man's life measure not some small growth or rearrangement or moderation of what he learned in childhood, but a great upheaval."[2]

Increasing concern with the organization's ability to cope is evidenced in the current writings of such organizational specialists as Argyris, Trist, Rice and Bennis. They argue that an organization's effectiveness should be defined as its capacity to survive, adapt, maintain itself and grow.[3] Bennis in particular states:

> "If we view organizations as adaptive, problem solving, organic structures, then inferences about effectiveness have to be made, not from static measures of output but on the basis of the processes through which the organization approaches problems."[4]

There is increasing evidence that large organizations possessing the means for survival have, in many cases, failed to do so. Two organizational theorists, Richard Cyert and James March have attributed these failures to the

organization's increasing inability to cope with the uncertainty that normally accompanies change.[5]

The organization leader as a change agent

Many organization theorists have suggested that the blame for the organization's inability to cope lies squarely on the shoulders of its leader. George Steiner, for instance, has characterized this failure.

> "The presidents of corporations have been ducking their jobs....They seem to follow the practice of setting in a fuzzy way some objectives to be accomplished in the future and establishing a committee, with the staff help of the planning group, to come up with a plan for achieving the objectives. From this point until the plan is handed to him the president abdicates his responsibility."[6]

Steiner sees the corporate president's role as that of chief planner and change agent but criticizes the failure to assume this role. Bennis agrees with Steiner on this deficiency of the corporate president but attributes this failure to a certain missing personality characteristic. This missing characteristic is described as resistance to uncertainty.[7] Joe Kelly agrees with these two theorists but his outlook is more optimistic. He feels that the necessary personality characteristics are present in organizational leadership. He describes the effective leader of the future.

> "This represents the nub of managerial life in the sense that the modern manager has to live with a fair amount of uncertainty in an environ-

> ment which is frequently suffused with ambiguity and conflict. Fortunately, many of the most effective managers seem to prefer this kind of situation mainly on account of their ability to restructure it in their own interests."[8]

Galbraith, in The New Industrial State, describes a new type of manager who makes extensive use of the new and fastly developing technologies to gain an advantage over the "economic man." The developing manager reacts quickly to external change and has learned to adapt to internal change.[9] Internal change is described in terms of labor mobility or turnover which has increased five fold since the Korean War.[10]

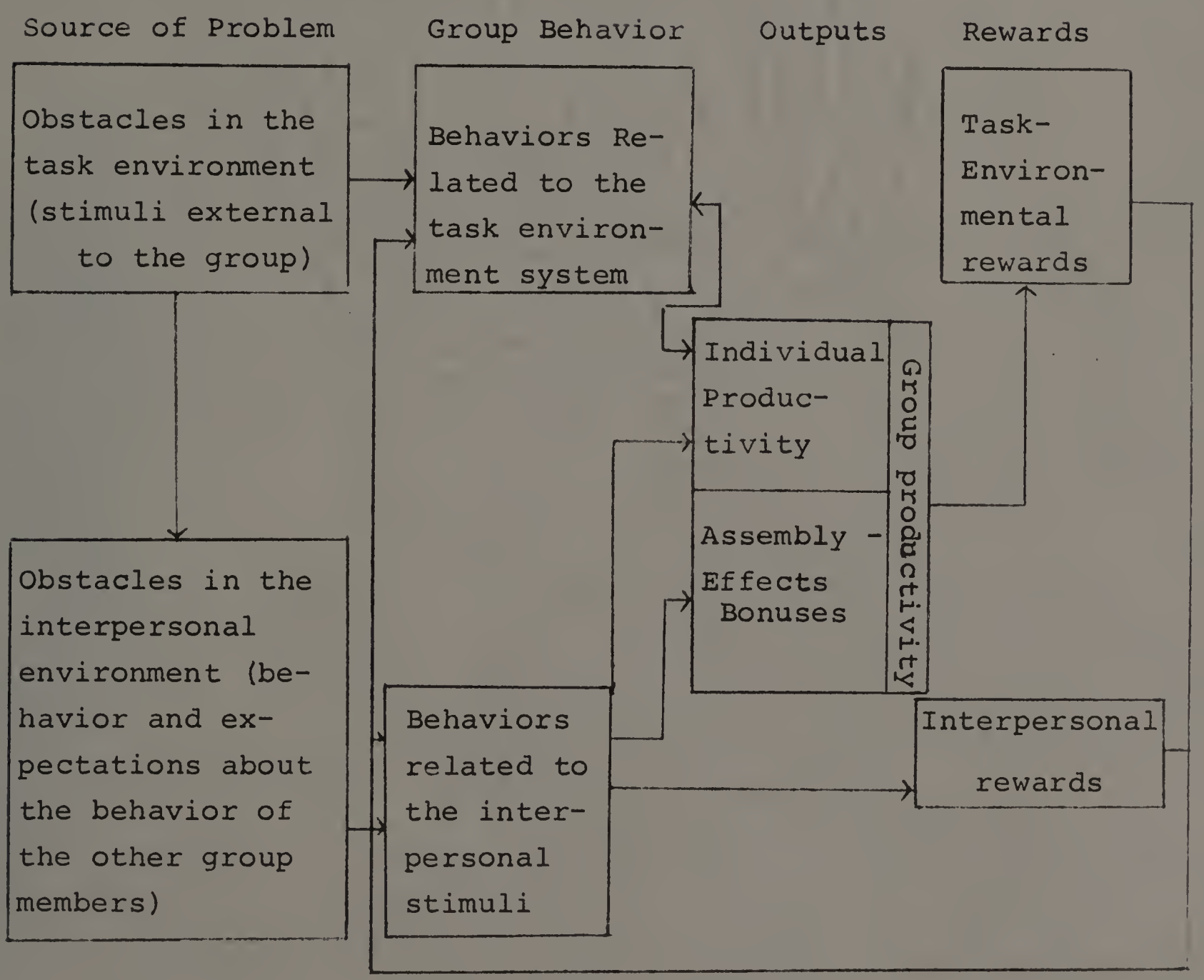
Group task and social structures

Group adaptation to change

The process by which the group adapts to change may provide some useful insights for future studies of change. Group adaptation to change is described by Collins and Guetzkow as a decision making process. Change creates problems requiring decisions from the group. Collins and Guetzkow describe the process by means of their model. The model is illustrated on the following page. The model indicates two basic needs which it characterizes as task and interpersonal. Task and interpersonal needs can be variously described as external and internal corresponding to the external and internal needs of the group which result from

The Collins and Guetzkow Group Decision Model*

MODEL #1



*Collins, B. and H. Guetzkow (1964). A Social Psychology of Group Processes for Decision Making. New York: Wiley, p. 69-87.

the problems of external and internal change. The model characterizes the task and interpersonal needs as mutually exclusive. Therefore, a group cannot satisfy both needs simultaneously but must alternate its attention concentrating on the most important need. The model further states that these needs may be more efficiently satisfied if task and social leadership are treated as separate functions implying separation of task and social leadership.[11]

Definition of group

Proshansky and Seidenberg have suggested that most social psychologists use the term "group" to refer to two or more individuals who can be collectively characterized as sharing a common set of norms, beliefs and values and existing in implicitly and explicitly defined relationships to one another such that the behavior of each has consequences for the others. These properties emerge from and have consequences for the interaction of individuals who are similarly motivated with respect to some specific objective or goal.[12] Joe Kelly adds a task dimension to the aforementioned definition.

> "Inevitably on account of their interdependence, which after a time becomes institutionalized, the members develop an ideology which implies that they have a common set of values, beliefs and norms which regulates their behavior and attitudes. The group ideology is developed as the group works on particular tasks and may become peculiar to the group."[13]

The problem solving model

Further, in depth attention is now given to the Collins and Guetzkow model. This model is based on the task and interpersonal systems suggested by the works of Homans, Bales, Cattell, and Thibaut and Kelley.[14]

Homans describes a basic structure for groups. He sees the crucial elements of this structure as: (1) activities - the acts of the members of the groups, (2) interaction - the independent and interpersonal behavior of the members, and (3) sentiment - the positive or negative feelings of the members for one another. He theorizes that each group has a boundary separating it from the environment which may be physical, technical, or social. The survival of the group depends upon its ability to solve environmental problems. The internal system of activities, interactions and sentiments enables the group to overcome obstacles in the environment. The fact that a group does exist proves that its internal system is currently viable but its continued health depends on its continuing success with its environment. Homans goes on to say that the internal system is subject to entropy and that some of the group's energy must be spent to maintain the internal system. Such an allocation of energy between the external and internal system is necessary to maintain group equilibrium.[15]

Bales found in some of his studies on the adaptive and

integrative changes of groups that the increased differentiation of roles and the stratification of structure which facilitates task activity will create interpersonal problems within the group. He theorized that the pressures resulting from increasing task orientation give rise to counter pressures for group integration. Therefore, the structure which is best suited for task purposes may not satisfy the interpersonal needs of the members. He further theorized that all groups are caught in temporary states of equilibrium. Each new task or interpersonal problem creates a movement towards a new point of equilibrium.[16]

Cattell also discusses the task and interpersonal needs of the group. He states:

> "The sum total of the energy which any group can command or expend, I have called synergy; and the synergy will be a fúnction of, for example, the number of members and the strength of the group interests of each. It is easy to perceive that this synergy is expended broadly in two ways which are distinct in important respects. First, a substantial part, which we may call maintenance synergy, will be used up in the internal machinery which keeps the group in being, leaving the residue, which we may call effective synergy, to carry out those purposes for which the group explicitly exists."[17]

A more complete review of Cattell's analysis of small groups can be found in a joint article by Cattell and Stice.[18] Homans, Bales and Cattell emphasize the joint existence of task and interpersonal systems within the decision making group. Collins and Guetzkow further develop

these concepts and add the concept of a dynamic system dependent on and respondent to its environment with a mechanism for maintaining its equilibrium. The Collins and Guetzkow model (see page 5) examines the group's response to problems originating in both the external and internal environment. These problems are treated as stimuli requiring a group response. Analogously, these stimuli can be characterized as external and internal problems requiring decisions from the group. The model describes external stimuli as originating from the external environment and constituting the task problems faced by the group while interpersonal stimuli are described as originating from the internal environment and constituting the interpersonal problems faced by the group.

The model maintains that rewards mold, maintain and motivate group behavior. If the obstacle is from the group's external environment, the group's synergy must be task oriented. If the obstacle originates from within the group, synergy must be maintenance oriented. There is an interrelationship between obstacles and also between rewards. External obstacles can create internal obstacles which must be overcome before the external obstacles can be attempted. On the other hand, interpersonal rewards can reinforce task related behavior. The internal obstacles may be more formidable than the task related obstacles.

The model further maintains that productivity is a function of the successful overcoming of both external and internal obstacles. Productivity results from the group's successful task oriented behavior and also from a bonus resulting from the interpersonal system called the "assembly effect." Assembly effect is defined as the excess of group productivity over that which would have resulted had each member worked in isolation. The bonus may be positive or negative.

The model indicates that group productivity receives a task environmental reward from outside the group boundaries. The reward acts as feedback reinforcing successful behavior. Interpersonal rewards can also reinforce successful behavior. Because interpersonal rewards originate from within the group structure, it is possible for these rewards to be generated independently from group productivity. In a task oriented group, these rewards reinforce the task behavior of the group with the major reward coming from the environment. However, it is possible for the group to motivate behavior which does not contribute to productivity or even interferes with it in some way. In other words, it is possible to mold, maintain and motivate behavior which reduces productivity. However, because it is impossible to survive on love or status alone; interpersonal rewards are generally used to facilitate long-run produc-

tivity.

The concept of interpersonal rewards as being necessary to maintain long-run productivity is supported by the "common fate" studies by Collins and Guetzkow, Egerman, Hall, Rosenberg, and Zajonc.[19] In these studies, no task-environmental reward was forthcoming and yet the group continued to mold, maintain and motivate those behaviors which would eventually produce rewards. To this end, the group must have available such interpersonal enforcers as status, deference, etc., which can be applied or withdrawn in accordance with the activities of the group member.

Task and socio-emotional roles

The Collins and Guetzkow model illustrates the existence of two basic group roles - task and socio-emotional leadership roles. Borgatta has observed that the task leadership and socio-emotional leadership functions are two well differentiated and recognizable roles best filled by different people.[20] This finding was supported and further developed by Bales.[21] A study of the task oriented, human relations oriented, and a combination of task and human relations oriented styles of leadership indicated that the combination of the two resulted in the highest level of productivity, the task oriented style was second while the human relations style was third.[22] From the Borgatta and

Bales studies we find that the task and socio-emotional roles are best filled by different people. Occasionally, however, a leader arises possessing both sets of characteristics and capable of filling both roles. These occasional "stars" are so rare as to justify only a mention.

The conditions under which a leader operates are important in determining which style is more effective. Fiedler has shown that the leaders of more effective groups tend to be those who are concerned with the successful completion of the task if the situation is very easy or very difficult for the leader. Where the situation is of intermediate difficulty, the more effective leader is one who devotes his attention primarily to friendly interpersonal relations.[23]

Considerable attention is given to the role of the leader in determining group effectiveness. For the purpose of this study, the leader is considered a high status member of the group and his effect is similar to that of any group member only more profound and longer lasting. This concentration does not diminish the importance of the other group members to group productivity. This study will consider and evaluate the effect of both the leader and the follower on group productivity.

Effective leadership personality

Gibb found that an effective leader must make a contribution to "group locomotion."[24] The type of leader who "best" contributes to the locomotion and effectiveness of the group has been described by Argyris as "reality centered" and task oriented. Argyris's contention is that the most effective pattern of leadership used by organizational executives is flexible; selecting that style which seems appropriate given a particular situation. In other words, the reality centered leader chooses that style of leadership in a given situation which maximizes the payoff for any set of interpersonal factors. Reality centered leadership requires that the leader diagnose a given decision making situation with a minimum amount of emotional distortion and then choose the most appropriate style. Argyris goes on to say that the reality centered leader will indicate socio-emotional tendencies only when that style facilitates task completion.[25]

Some of the earlier work on task leadership resulted from the research of Sherif and Sherif. In their basic study on the emergence of task leadership through the mechanism of competition, they used two groups of campers and artifically stimulated competition between them. The results indicated that the social leader was dominant during the early non-competitive period. However, when the

competition began, the high status member with the greatest task ability took charge.[26]

Psychological distance and task orientation

Fiedler found an important characteristic of a task leader to be the psychological distance which he maintains between himself and his followers. Psychological closeness handcuffed a leader when he had to put pressure on his employees. The psychologically distant managers or PDM's were more effective where conditions were either favorable or unfavorable. Fiedler explained their effectiveness by stating that a manager who is emotionally dependent on a subordinate cannot effectively discipline him. However, he implied that discipline might not be the optimal course of action when conditions were somewhere between favorable and unfavorable.[27]

Fiedler devised an ingenious technique for determining psychological distance. The manager is asked to rate his most preferred and least preferred subordinates on various psychological traits. The greater the distance between these two ratings, the more psychologically distant the manager is assumed to be. The PDM is further characterized by his rejectance of those with whom he cannot work easily. The psychologically close manager or PCM is more tolerant of his subordinates. The PDM is considered to be the task

specialist.

Two portraits emerge from Fiedler's work. First the PDM has the following characteristics:

1. He tends to formalize role relationships with superiors and subordinates.
2. He tends to be reserved in his interpersonal relationships.
3. He prefers formal staff consultation.
4. He accepts or rejects subordinates on the basis of performance.
5. Though reserved he is interpersonally smooth.
6. He does not develop friendships with his work colleagues.
7. He demands and gets considerable freedom of action.
8. He expects subordinates to make mistakes and plans accordingly.
9. He prefers ambitious subordinates.

The PCM is relatively inefficient in favorable and unfavorable situations but more efficient in those situations in between. He has the following characteristics.

1. He prefers informal role relationships.
2. He is more concerned with good human relations than with task achievement.
3. He is inclined to select friends from among

colleagues and subordinates.

4. He dominates and attempts to possess subordinates.
5. He prefers not to delegate and requires frequent consultation.[28]

Kelly predicts that the executive of the seventies will be a task specialist who can systematically vary his psychological distance with both his superiors and his subordinates. Kelly expects this future executive to show considerable adaptability in the selection of roles as he reacts to either conflict or cooperation. This executive will develop a spectrum of leadership responses from which he will select the most appropriate depending on the circumstances. Kelly's description appears to incorporate both Fiedler's psychologically distant manager and Argyris's reality centered leader.[29] These personality characteristics also compare favorably with those found by Cattell and Stice in their study on the relationship of personality characteristics and leadership effectiveness. Cattell and Stice found that "deliberate will control" differentiates significantly between leaders and non-leaders. The determination, stability of purpose and organizational precision associated with "deliberate will control" enables a person to see his decisions through and to organize the group with a high degree of consistency. Cattell and Stice also found

that the level of nervous tension, absence of anxious worrying, and ego-strength also differentiated. Deliberate will control can be variously described as resistance to social persuasion while the other measures can also be described as emotional detachment and cognitive orientation.[30]

Personality and the task leader

A summary of those relevant characteristics of the successful leader would describe him as task oriented but not rigidly so. It would further characterize him as being emotionally detached, cognitively oriented with a freedom from emotional distortion and a certain immunity to social pressure. By contrast, the socio-emotional leader could be characterized as emotional, empathetic, distractable, human relations oriented with a definite susceptability to social pressure. The task leader's primary concern is the completion of the task and his activities are generally geared to its achievement. This theory is in direct contrast to other theories such as trait theory; which has generally fallen into disrepute because of its inability to consistently predict behavior.[31] Christie and Geis have developed a new personality dimension which seems to measure many of the characteristics of the successful leader. This dimension has been entitled

"Machiavellianism." A tabular summary of the aforementioned leadership characteristics and the relationship of these characteristics to the Mach characteristics is given on the following page.

The Machiavellian syndrome

The Machiavellian syndrome is a collection of personality characteristics describing behavior which is: (1) cognitively oriented, (2) emotionally detached, and (3) resistant to social pressure.[32] The relationship between these characteristics and the previously described concepts of task leadership, psychological distance and reality centered leadership becomes obvious in Chapter II. The concepts provide the background or framework against which the Mach concept can be evaluated. The Mach concept will be more fully developed in the next chapter.

Purpose of research

The literature previously reviewed suggests that Mach may be positively related to performance. Therefore, the purpose of this research is to evaluate the effect of the Mach dimension on the process of decision making performance through a measure of group productivity. The problem posed for this research is concerned primarily with the effect of the Mach dimension on the decision making effec-

TABLE #1

Relationship of Mach to Prior Research

MACHIAVELLIAN CHARACTERISTICS	SUPPORTING RESEARCH	
	Author	Concept
Low Mach-Socially Oriented 1. Socio-emotionally oriented 2. Emotional close 3. Responsive to social pressure	(Not directly described)	(No attempt is made to relate to existing literature)
High Mach-Task Oriented Characteristics: 1. Cognitively Oriented 2. Emotionally Detached 3. Resistance to Social Pressure	Sherif and Sherif Argyris Gibb Collins and Guetzkow Cattell Fiedler Cattell	Task Leadership Reality Centered Leadership Group Locomotion Primacy of Task Absence of Anxious Worrying Psychological Distance Deliberate Will Control
High-Low Mach Combination (Includes members having both characteristics)	Collins and Guetzkow Homans Bales Borgatta Cattell Kelly Argyris	Group Decision Model Task and Social Needs Task and Social Functions Exclusive Functions Effective Leader Characteristics Future Leader Reality Centered Leader

tiveness of the groups both before and after a change in the composition of the groups caused by a change of leaders.

Summary

Changes in the internal and external environment of goal oriented groups causes corresponding changes in the decision making machinery of the group and ultimately in its effectiveness. In order to perform effectively the groups must integrate these changes into its decision making framework realizing that the speed with which it incorporates change will affect its productivity. Groups whose leaders and followers possess those personality characteristics allowing the speedy incorporation of change are hypothesized to be more effective.

The Mach syndrome is assumed to reflect characteristics especially effective in facilitating the incorporation of change. Therefore, the Mach syndrome will be examined for the purpose of determining the extent of its effect on group performance.

CHAPTER II

THEORY AND RESEARCH

This chapter examines the theoretical background of the Mach concept, its relationship to group decision making effectiveness and some of its personality and situational correlates. General hypotheses are then stated which test the validity of some of the personality and situational assumptions underlying the Mach concept. The Mach concept to be developed in this chapter was provided with theoretical foundations in the prior chapter. A brief description of the Mach personality was given and this description will be expanded more fully later in this chapter.

Some necessary definitions

Some definitions necessary to a more thorough examination are taken from Fiedler's work.[33] They are:

(1) Leader - that individual in a group given the task of directing and coordinating the group's task relevant activities.

(2) Leader effectiveness - defined in terms of group performance on the group's assigned task.

(3) Leadership - an interpersonal relationship in which power and influence are unevenly distributed so that the leader is able to

> control the activities of others to a greater extent than they do his.

The Machiavellian syndrome

The pioneering work of Christie and Geis describes the Mach syndrome in terms of a collection of situational and personal characteristics. The situational characteristics are further described as face-to-face interaction, latitude for improvisation and irrelevant affect which are in turn defined as:

(1) face-to-face interaction - exists in a situation where two or more individuals are engaged in a common task for the purpose of achieving a common goal.

(2) latitude for improvisation - exists in any situation where there is a sufficient amount of ambiguity requiring the subject to improvise both the timing and the content of his responses. This improvisation is limited to cognitive improvisation.

(3) irrelevant affect - described as the emotional disruption normally arising in an interpersonal interaction. Any decision making group would give rise to irrelevant affect.[34]

It should be emphasized that all three situational characteristics are generally present in a group decision making situation. For example, the members of a decision making group generally meet face-to-face; the group's primary task of problem solving through decision making implies the existence of some uncertainty or ambiguity; and

irrelevant affect is present in interpersonal interactions.

The Mach syndrome is additionally the function of some personality characteristics. Christie and Geis list these characteristics as: (1) emotional detachment, (2) cognitive orientation, and (3) ego-strength.[35]

Christie and Geis's Mach syndrome takes its roots from Machiavelli's The Prince and The Discourses.[36] Implied assumptions on human nature were reinterpreted in modern terms and used to form a questionnaire. This questionnaire was tested and revised resulting in the current Mach V instrument.

Christie and Geis characterize the Mach in terms of the following predispositions based on studies where these predispositions were indicated by most or all of the more successful high Machs.

(1) The high shows a cool detachment whereas the low is more apt to become emotionally involved.

(2) The high is less likely to become involved with other people, with sensitive issues, or with face saving embarrassment.

(3) The high's coolness may not be more than skin deep because he appears to be sensitive enough to avoid the enticements or dangers of interpersonal involvements which might interfere with task achievement.

(4) The high shows a lack of susceptibility to sheer social pressure urging compliance, cooperation, or attitude change -- a characteristic which in turn accounts

for his being no more likely than a low to be mislead by inducements to lie or cheat.

(5) The high's cool allows him to focus on explicit cognitive definitions of the situation and to concentrate on strategies for winning, while the low gets carried away in the direction proposed by the high. The high's tendency to act by what he knows makes him more successful in exploiting the situation.

(6) Evidence to date indicates that the high is not more hostile, vicious or vindictive when compared to the low.

(7) The high has as little defensive investment in his own self-image or beliefs as he has in others or interpersonal relations.

(8) High Machs tend to initiate control and structure in their groups. Evidence is inconclusive as to whether this indicates a more independent or active process.[37]

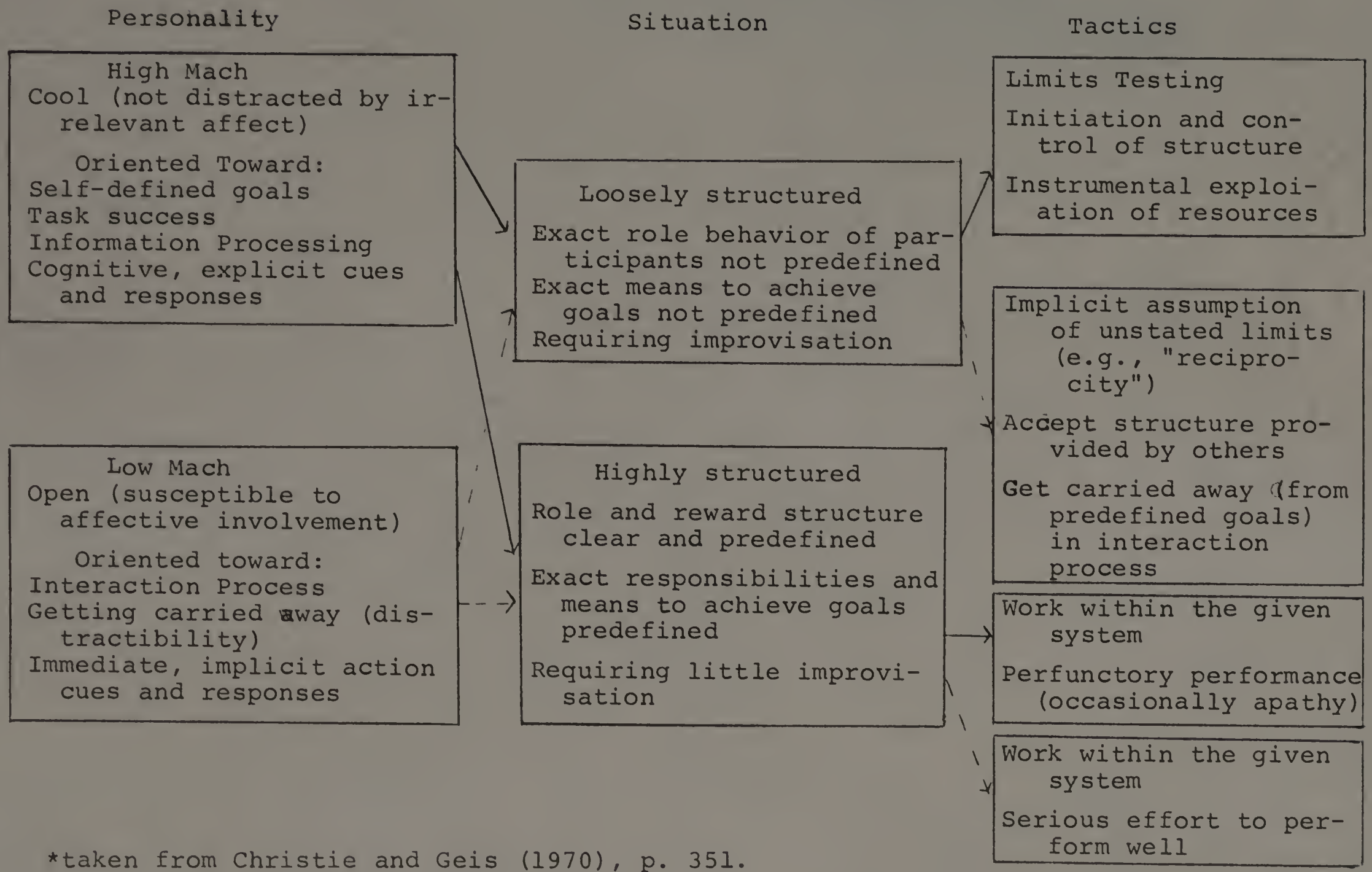
By way of summary, the personality of the Mach as it interacts with various situations produces the following tactics. See the illustration on the following page.

Other relevant Mach characteristics

Some other factors relevant to the Mach syndrome should also be discussed. Christie and Geis found that highs were task oriented in winning while the lows were ego involved with the details that arose with the bargaining process. In other words, lows were distracted from winning by irrelevant emotional involvements. They got carried away by their empathy for other people.[38] Nor can

The Christie and Geis Mach Model

MODEL #2



*taken from Christie and Geis (1970), p. 351.

the competitive advantage shown by the high be attributed to superior intelligence because no significant linear correlation could be found between intelligence and Mach.[39] Guterman in his book, The Machiavellians, found that a strong superego correlates negatively with Mach.[40] He suggested that a weakened superego can result from flexible moral attitudes on the part of the parents. On the other hand, he felt that a strong superego reflected a fear of loss of love of the parents, warmth shown by the parents and firmness of the parents' beliefs.[41] Guterman also found a positive relationship between Mach and outward directed hostility.[42] Christie and Geis would agree with Guterman's conclusions for the most part but would add that Mach is negatively related to empathy and that high's succeed better in the real world.[43] In addition, they found a negative correlation between Mach and age.[44]

A synthesis

The characteristic which seems most essential to the real world effectiveness of the high Mach is emotional detachment. Emotional detachment when associated with cognitive orientation and resistance to social pressure enables the high to more effectively combine people and resources to achieve at least a short-run optimum in productivity. His persuasiveness as described by Christie and Geis, re-

inforced by his resistance to social pressure seem to suit him well for the position of group leader.[45] Along the same line of thought, French in his study of interpersonal power relationships found that:

> (1) For all possible patterns of initial opinion in a completely connected power structure, the opinions of all members will reach a common equilibrium level equal to the mean of the group.
>
> (2) In a unilaterally connected group, the opinions of all members will converge to a final common opinion in an indefinite number of steps. If there is one person in the group with zero emotional input (i.e., no emotional involvement), then all members will eventually agree with him because he can influence others but they cannot influence him.[46]

Therefore, the high Mach's emotional detachment and ego-strength seem to suit him especially well for the position of group leader. It may be well to differentiate, at this point, between an appointed leader and the high status person who influences more and is influenced less.

Based on the research of Borgatta and Bales a combination of high and low Mach can be hypothesized to be the most stable and therefore, the most productive in the long-run. The high Mach is most generally characterized by his emotional detachment, cognitive orientation and ego-strength. It is these characteristics which cause him to be task oriented. From the work of Borgatta and Bales shown in Chapter I, the socio-emotional problems created by a task leader

leads to increased interpersonal needs for group members which must be satisfied if long-run productivity is to be achieved. The work of Borgatta and Bales proposes a combination of task and social leadership to be the most stable and therefore, the most capable of sustained productivity. From the previously mentioned descriptions of high and low Mach, a parallel can be drawn between high Mach and task oriented and between low Mach and socio-emotionally oriented leadership.

Change of leader

Another source of interpersonal problems and socio-emotional needs occurs with a change in role sets and role expectations. The most serious changes occur with a change of membership in a decision making group. The impact of the change increases as the status of the member being changed increases so that a change of a high status member, such as a leader, can be expected to have a more serious impact than a change of some low status member. These conclusions are supported by the work of Pryor, Flint and Bass; Nash and Wolfe; Ziller; Ziller and Behringer; and Ziller, Behringer and Jansen.[47] These authors maintain that the disruption of established patterns resulting from change of members and/or leaders has a negative effect on the productivity of the group. This negative effect varies directly

with the status of the member and the success of the group prior to the change. These authors admit that in some cases a change may be welcomed especially if the group is, competitively speaking, unsuccessful or if the member to be changed is low status and the member to be received is perceived to be of potential value to the group.

A partial summary of the research of these authors will be made to support the above contention. For instance, Nash and Wolfe found that the introduction of a stranger into a group caused a temporary decline in the number of inventions where the primary task of the group was inventions.[48] Ziller and Behringer, in a longitudinal study of the assimilation process of a new student found his popularity to decrease sharply after joining the group and then to begin a steady rise until it reached a stable state.[49] The decline in popularity paralleled a decline in productivity on the part of the newcomer. Ziller found a group threatened by something which he called "ego diffusion" whenever a new member was admitted to the group. He defined ego diffusion as the difficulty an individual has in distinguishing his uniqueness. This difficulty occurs when contrasts and similarities between self and others fail to be perceived and the result is an amorphous or obscured self-portrayal. The implication of this research is a concentration of the energies of the group on the assimilation of the newcomer

which, in turn, requires a weakening of values and expectations. Ziller terms this process as socialization. Once the process is completed the group can return its attention to business as usual.[50] The aforementioned researchers concentrate their attention on member change and to date no known research has been done on the impact of leadership change.[51]

Summary

A summary of the existing theory and research on the Mach personality shows the high as well suited to effective decision making under conditions of change. The high's personality characteristics of emotional detachment, cognitive orientation and ego strength which make him resistant to the emotional involvment accompanying decision making also interferes with the satisfaction of the group's interpersonal needs. This problem is described by Collins and Guetzkow in Chapter I. This lack of attention to the socio-emotional needs of the group can create morale problems resulting in such negative factors affecting productivity such as turnover, absenteeism and withdrawal of committment to the task goals of the group.[52] Although no actual research evidence exists, it is implied from the description of the low Mach that he has the characteristics to satisfy the

group's interpersonal needs.

Group decision making effectiveness can be measured in terms of productivity; this study will make that assumption. Further, theory and research give support to the positive relationship of Mach and productivity. However, the relationship is complicated by the fact that the task oriented high Mach concentrates on the task needs of the group to the exclusion of the socio-emotional needs whereas the low Mach is concerned primarily with the socio-emotional needs. Therefore, it is assumed that group productivity is best achieved by a combination of high and low Mach personalities. Membership change is assumed to have a negative effect on group productivity. These assumptions will now be stated as general hypotheses and subsequently operationalized. Finally, they will be tested and the conclusions based on these tests will be presented.

The general hypotheses

The general hypotheses are presented supported by a statement relating the hypothesis to the pertinent theory and research.

HYPOTHESIS I. Productivity is a positive function of the average of Mach scores of task oriented homogeneous groups.

This hypothesis follows from the theory and research of

Christie and Geis stating that emotional detachment, cognitive orientation and ego-strength of the high Mach allows him to focus on the explicit cognitive definitions of the situation and to concentrate on strategies for winning while the low Mach is initially distracted by the emotional involvement normally occurring in decision making groups.

HYPOTHESIS II. Relative improvement in the productivity of groups over time is greater, the higher the Mach score of the group.

This hypothesis describes an interactive effect involving high and low Mach groups. The theory of Christie and Geis suggests that the high Mach groups are expected to indicate an increasing productive advantage over low Mach groups because of the high Machs ability to resist the effects of ambiguity and uncertainty while concentrating on stragegies for winning.

HYPOTHESIS III. Change of leaders will have a temporary negative effect on the productivity of all task oriented groups.

The general decrease in the productivity of all groups derives from the theory of Ziller, among others, describing the disruptive effects of a change in membership on the productivity of task oriented groups.

HYPOTHESIS IV. Productivity of groups is a positive function of the Mach score of the followers following a change of leaders.

The personality characteristics of emotional detachment, cognitive orientation and ego strength will result in a positive correlation between the Mach scores of the followers and group productivity following a change of leaders. Support can be found in the theory and research of Christie and Geis.

HYPOTHESIS V. Productivity is directly related to the Mach score of the leaders following a change of leaders.

Christie and Geis suggest that the personality characteristics of the high Mach leader are expected to give him a competitive advantage for those periods following a change of leader. The advantage of the high Mach leader is positively related to the ambiguity or uncertainty existing at the time a decision is made. The high Mach leader is also more proficient in persuading the similarly inclined high Mach followers and the more easily persuaded low Mach followers. The opposite situation exists for the low Mach leader.

HYPOTHESIS VI. Productivity functions of the heterogeneous groups tend to converge over time.

This hypothesis describes an interactive effect involving heterogeneous Mach groups. The high Mach leader - low Mach follower group is expected to have a lower initial productivity because of the competitive disadvantage of the low Mach group during the first four periods of operation when the group operated as a low Mach homogeneous group. The competitive disadvantage of low Mach groups was previously explained. The productive gap is expected to diminish over time as the level of uncertainty diminishes with repeated decisions. The situational characteristic of ambiguity of uncertainty is responsible for the high Mach's advantage. Support can be found in the theory and research of Christie and Geis.

HYPOTHESIS VII. Rate of improvement in the productivity of the groups is greater the lower the Mach score of the followers following a change of leaders.

According to the theory of Christie and Geis, the primary cause of the productive gap between high and low Mach follower groups is ambiguity. This gap is reduced and the level of ambiguity declines in response to the repeated trials performed by the groups. In other words, the productive gap is inversely related to the learning effect accompanying repeated trials. A complicating factor arises

in the combination of heterogeneous and homogeneous groups necessary to study the impact of the follower dimension on the productivity of groups. This complicating factor will be more fully developed in the next chapter.

HYPOTHESIS VIII. Rate of improvement in the productivity of groups is greater the lower the Mach score of the leaders following a change of leaders.

According to the theory of Christie and Geis the primary cause of the differences in productivity is the level of ambiguity. High Mach leaders should react more positively to this factor. High Mach leaders should adjust more quickly to the initial level of uncertainty following the change of leaders but this difference should diminish with repeated trials. The complicated effect of combining heterogeneous and homogeneous groups again arises and this factor will be dealt with in the next chapter.

HYPOTHESIS IX. Productivity is positively related to the heterogeneity of the Mach scores of the group.

The theory and research of Bales, Borgatta and others indicates that groups having both task and socio-emotional leadership can be expected to outproduce groups that have either one. A heterogeneous group is hypothesized to satisfy more of the needs of the members contributing to the

in the combination of heterogeneous and homogeneous groups necessary to study the impact of the follower dimension on the productivity of groups. This complicating factor will be more fully developed in the next chapter.

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HYPOTHESIS IX. Productivity is positively related to the heterogeneity of the Mach scores of the group.

The theory and research of Bales, Borgatta and others indicates that groups having both task and socio-emotional leadership can be expected to outproduce groups that have either one. A heterogeneous group is hypothesized to satisfy more of the needs of the members contributing to the

greater stability of the group and subsequently to greater productivity.

CHAPTER III

METHODOLOGY

This chapter is concerned primarily with operationalizing the basic theoretical approach and then testing it. This goal requires a discussion of the design and methodology followed by a discussion of the reasons for using the chosen statistical design to test the general hypotheses. To facilitate the purpose of the chapter the order of the topics will be: (1) operational definitions, (2) the Mach V instrument, (3) research design, (4) selection and assignment of subjects, (5) change of leadership, (6) group task, (7) operational hypotheses, (8) statistical design, and finally, (9) a summary.

Operational definitions

For the purposes of this research the following operational definitions will apply:

(1) High Mach - those scoring in the upper third of all those subjects completing the Mach V instrument (to be described later).

(2) Low Mach - those scoring in the lower third of all those subjects completing the Mach V instrument.

(3) Leadership change - random exchange of leaders among the various groups.

(4) Group productivity - measured in terms of the ratio profit to total assets.

(5) Profit - the difference between revenues and expenses for a given period provided by the simulation game printout.

(6) Total assets - cumulative measure of all the liquid and non-liquid holdings of a company competing in the simulation game.

(7) Leader - first member of the company who is randomly chosen from the subject sub-population.

(8) Follower - second and third members of the company who are also randomly chosen from the subject sub-population.

(9) Homogeneous groups - groups containing a leader and followers of the same Mach.

(10) Heterogeneous groups - groups containing a leader and followers of opposite Mach.

The Mach V instrument

The Mach V scale is composed of twenty statements essentially derived from seventy-one items believed to be theoretically congruent with Machiavelli's The Prince and The Discourses.[53] The Mach V instrument utilizes the same Likert forced choice format used in the Mach IV instrument but contains an additional or buffer response. The buffer

response is designed to eliminate the effects of social desirability on the subject's responses.[54] The instrument was found to differentiate significantly at the .05 level.[55]

The Mach IV instrument was composed of twenty statements chosen from the seventy-one items previously mentioned. These statements were believed to be the best ten statements worded in the Mach direction and the best ten worded in the opposite direction. The mean reliability on the twenty item Mach IV scale based on nine samples was .79.[56]

Negative correlations between Edwards' (1957) Scale of Social Desirability and Mach IV ran from -.35 to -.45 among male undergraduate samples. Correlations among female undergraduates were around -.75. Edwards' scale indicates the extent to which respondents are unwilling to attribute unpleasant personal characteristics to themselves.[57] These correlations were neutralized by means of the buffer statement in the Mach V instrument. The Mach V instrument was adapted from a technique suggested by Heineman.[58]

The Mach V instrument is shown in Appendix A. The items are scored using a system in which a score of 100 corresponds to a theoretical neutral point where agreement or disagreement with the statements balances out. A score of 160 means strong agreement with a pro-Machiavellian

position while a reverse score has the opposite implication.[59]

A summary of the linear correlations of the Mach instrument with other paper and pencil inventories is helpful in constructing the Mach's position within the framework of existing research. No significant linear correlation was found for Mach scores and intellective abilities in seven studies listed by Christie and Geis.[60] In addition, this author's own exploratory and ex-post facto research indicated no linear correlation between Mach scores and intellectual ability. No linear correlations have been found to date between Mach scores and political preference. High Machs have been found to have unflattering opinions of others, but there is no evidence of a relationship between psychopathology and Mach. It has been postulated instead that the high Mach is exceptionally candid. It is unclear whether the high Mach is more hostile or whether they are less inhibited in expressing their opinions.[61]

There is a negative linear correlation between age and Mach scores. Studies attempting to relate Mach to urban and rural dwelling were unsuccessful. However, significant correlations were found between the subject's area of birth and early childhood and Mach scores.[62] Further, no relationship was found between Mach and status.[63] No relation-

ship was found between Mach and the F-scale or between Mach and Rokeach's measure of rigidity and flexibility.

Christie and Geis validate their instrument by specifying the various personality and situational factors or constructs which account for the variance in the test results. In terms of the personality factors of cognitive orientation, emotional detachment and resistance to social pressure, the authors zero in on these factors through other related research and their own prior research. The results of the many experiments reviewed in their latest book, Studies In Machiavellianism, lend support to their contention that the aforementioned personality factors are crucial in explaining the variance in Mach scores. Similarly, the authors describe three situational factors which they find crucial in explaining the differences in scores. They found that where the factors of face-to-face interaction, latitude for improvisation and irrelevant affect were present, the high Mach won in twelve of thirteen instances. Further, the high Machs won in seven of nine instances where two of the factors were present but in only four of twelve instances where only one factor was present.[64]

A positive relationship was found between Anomia and Mach in a number of studies. Factor analysis was performed on items from the Mach IV, Mach V and Anomia Scale. The study dealt with a representative national sample of 1482

adults and 1782 students in widely assorted colleges. An examination of the relationship of these factors with education in the adult survey indicated a negative relationship between an embittered, an ill structured social outlook and education. Items reflecting Machiavellian tactics show no relationship to years of formal education.[65] There was a negative linear correlation between age and Mach score.[66]

Research design

The design involves a study of the relationship of Mach to productivity. Further, the relationship of the composition of groups to productivity is studied by altering the Mach composition of the groups to achieve homogeneous and heterogeneous Mach groups. Change of leadership is used to change composition. Finally, an attempt is made to isolate one of the situational determinants of Mach by testing for a decreasing difference in the productivity of the various groupings. It is assumed that initial differences are the result of the ability of heterogeneous and high Mach groupings to work more effectively under conditions of uncertainty and that uncertainty disappears in proportion to the learning effect caused by repeated decision making trials.

The simulation game

The Integrated Simulation by Smith, Estey and Vines provides the measure against which the efforts of the various groups are compared. The simulation is a more realistic instrument to test the relative productivity of the high-low Mach personality dimension.[67] Previously, all testing had been done in highly structured laboratory experiments of the type mentioned in the work of Christie and Geis.[68] The simulation is a more realistic but also more complex test of the relationship of Mach to productivity. The realistic nature of the simulation game has been described by Smith, Estey and Vines.

> "In the real business world, group interplay is the typical work situation. In the simulation where companies or teams are required to agree on a group decision, this interpaly is vividly recognized by every student.[69]

The basic rules of the Integrated Simulation require that a participant act in conjunction with two or more others as officers of an industrial organization. At each meeting twelve key decisions are made which will operate the company for the next quarter. The company competes with two other companies, all producing the same product, selling in the same market, and all starting with the same asset structure and financial prospects. Each company produces large industrial machines which enjoy a growing demand. The officers of each company are responsible for assets

that can grow to more than eight and one-half million dollars. Each time a set of decisions is submitted, the computer calculates a set of results which form the basis for the next quarter's decisions.

The simulation supplies those situational characteristics, generally present in a business environment, that are necessary to show the competitive advantage of the heterogeneous and high Mach groups. These characteristics are: (1) face-to-face interaction, (2) latitude for improvisation, and (3) irrelevant affect. Where these three situational characteristics were present, Christie and Geis found that the high Mach won in twelve of thirteen instances. In addition to winning, the high Machs persuaded more, were persuaded less, or behaved as predicted significantly compared to the low Machs. Further, the high Machs won in seven of nine instances where two of the factors were present but in only four of twelve instances where only one factor was present.[70]

The organization of the groups

The subjects were first organized into sixteen groups of three high or low Machs randomly selected from the outer thirds of those subjects who were tested with the Mach V instrument. Each group was composed of a leader and two followers who were to play twelve quarters of the simulation

game.

Each group was free to allocate the twelve decisions as it saw fit. However, the most common form of organization grouped those decisions into the functional areas of production and inventory, finance, and marketing. Each member was told that he would be graded partly on the results of the group and partly on the quality of his decisions apart from the performance of the group. To insure individual participation, the subjects were told that their final grade would be decided only after they had made an oral presentation of the strategy of their decisions to a board of directors following the conclusion of the decision trials. At the presentation, the contribution of each individual team member would be evaluated.

Selection and assignment of subjects

Subjects were senior Nichols College students fulfilling school requirements for the Management 491 (Computer) course. The simulation was part of the required work. Work in the simulation was to be graded as one-third of the total course grade or the equivalent of two quizzes. To reinforce the incentive to compete, a grade differential was established whereby the first place team would receive a maximum grade of A, the second team a maximum of B, while the third team would receive a maximum grade of C. Subtracted from

the team's maximum score would be penalties for infractions of the rules for playing the game, a copy of which can be found in Appendix B. Examples of such infractions are absence from a decision making trial, tardiness, failure to hand in the group's decision and any evidence of collusion.

Subjects were randomly assigned to the various groups with the leaders being assigned first and the two members being assigned when every group had a leader. The leader was chosen randomly from either the high Mach population or the low Mach population. Subsequently the followers were chosen in the same manner. Random assignment was made in an effort to cancel the effects of individual differences in intelligence and job related skills.

In any case, the controlling of job related skills was not expected to be a serious problem because the Nichols College seniors are all business majors having approximately the same basic job related skills. Environmental factors were not a problem because each of the sixteen teams worked in roughly identical study rooms. Therefore, it was assumed that all teams had approximately the same heating, lighting, ventilation and physical surroundings.

To help establish the leader's position, a special briefing was given to all group leaders ostensibly to discuss various winning strategies. The true purpose of the meeting was to establish the identity of the leaders and

covered only those strategies already covered by the Smith, Estey and Vines' manual of instructions.[71] All communications between the group and the experimenter were channeled through the leader to further reinforce his position. To prevent unfair competitive advantage and to discourage dependent relations between the leaders and the experimenter, requests for information were generally redirected to the player's manual. Requests for information of a competitive nature were frustrated by an exorbitant consultant's fee. After a few efforts to obtain information, most leaders took the hint and used the manual or worked without the information. Since the manual has complete instructions, no team suffered a competitive disadvantage due to lack of information.

In some cases, the leader was not accepted by the group. Complaints were made to the experimenter as to the ability of these leaders. These complaints were handled by reminding the complainers that real life business situations often found groups faced with a similar problem. They were told that the sign of a mature group is the ability to work with such a leader.

The size of a group was set at three because it is the minimum number of participants needed to play the simulation game. Four members was rejected because an equal number of participants might lead to unbreakably tied situa-

tions and facilitate the formation of opposing cliques. There were simply not enough available subjects to form groups of five. Throughout the experiment, the morale of the groups was excellent. Good natured kidding was observed between teams. Attendance, one indication of morale, was excellent. In addition, a survey following the final decision trial indicated that the subjects found the game interesting and indicated an interest in continuing the game. The alternates chosen at the start of the experiment were never used. In those few instances where a team member was unable to be present for a decision trial, the team asked for and was given an alternate time always before the results were computed. Motivation seemed high and there seemed to be a considerable amount of ego-involvement.

Group task

The simulation game provided the group task. The simulation is interactive and dynamic. These two characteristics, however, create some problems in the measurement of productivity but these problems are handled in the design.

The problem of interactive performance and the resulting interrelated productivity was solved by having each team compete against the same two dummy teams. Each team could be measured against the same standard thus eliminating the interaction and allowing the treatment of the individual

results as being independent.

It is also essential that all outside social interaction between the members of the various teams which might result in collusion be eliminated. To accomplish this goal, feedback should be as close to the group's decision as possible. Because it was impossible to have consecutive trials accompanied by the necessary feedback (the computer cycle is too long), it was decided to schedule all teams twice a week during the normal class periods and to supply the feedback and require the decision at this time. Therefore, each team was scheduled to meet twice a week for seventy-five minutes. These meetings were to continue for six weeks. A further step was taken to insure against the leakage of information. All teams were coded and the identities of the various members were kept secret. Teams were organized into competitive worlds which were also coded. Therefore, no team could be sure if it were competing against any other team. Because each team was competing against a dummy team, a comparison of prior output could present no matches. At the end of the game, the teams were surveyed to determine whether they suspected the identity of their competitors. The results of the survey indicated that no one suspected that their competition was anything but real although they could not pinpoint their competitors.

In most management simulation games, there is a danger of an early "wipe-out." The Integrated Simulation was carefully organized and designed by Smith, Estey and Vines to minimize the possibility of such an occurrence. The student manual provides detailed instructions including some basic strategies designed to prevent an early disaster. Sample decisions and results are also included to prevent recording errors.

The only change made in the simulation game was a change in the computer program to produce an extra copy of each team's results. This was done to provide the experimenter with a copy of each team's results necessary for the evaluation of each team's progress and for the comparison of productivity.

Change of leader

The study can conveniently be divided into two time periods. The second period hypotheses are differentiated from those of the first by the notation, "following change of leader." Groups compared during the first period were homogeneous high or low Mach groups. Groups studied during the second period are either homogeneous or heterogeneous. As previously defined, change of leader is a random process of exchange among the various groups so that their exists eight homogeneous and eight heterogeneous groups.

Group productivity

The choice of a single measure of productivity was difficult. Problems arose as to how companies of different size and prior success could be compared. Differences in assets would mean that the company with the larger asset structure would be able to excel in most measures of productivity. Prior success contributes to differences in productivity and to structural advantages. The single measure of productivity chosen was profit divided by total assets because it structurally compensates for differences in asset structure and prior success.

Weighting profits by total assets produces a measure which is relative to the size and thus to the prior success of the company. For example, a company with assets of eight million and earning four hundred thousand would have the same productivity ratio as a company with assets of six million earning three hundred thousand.

All teams were informed that the productivity ratio was to be the criterion by which they would be evaluated. Written instructions were given to each participant to this effect; a sample of which can be found in Appendix C. A question and answer period was held to answer questions on the productivity ratio and the rules for playing the simulation. Subsequent questioning by the experimenter seemed to indicate that the criteria of evaluation was understood

by all teams.

A decision trial

A sequential description of a decision trial might help the reader's understanding of the use of the simulation game. Decision trials were seventy-five minutes long and were held every Tuesday and Thursday of the six week period. Trials were held continuously on these days coinciding with the regularly scheduled class periods. Eight study rooms were made available for the experiment, although all eight were rarely used.

The members of each team were required to be in their assigned room prior to the commencement of the decision session. Teams with members who were not present at the start of the session were recycled for another period later in the same day or for the following morning. Such recycling was rare and was generally known in advance. Where it did occur, such delays were generally due to unasailable reasons for absences. Two student assistants not involved in the game were available to monitor the timing of the decision trials.

The decision trial began with the distribution of the previous quarter's results. Thirty minutes was allowed for the evaluation of results and the remaining forty-five minutes was allocated to the making of the current quarter's

decisions. At the end of the thirty minute review phase, the current decision forms were distributed. Five minutes prior to the end of the decision period a warning was given. The forms were collected with the ringing of the school bell signifying the end of the period. Teams not handing in their decision forms on time would be penalized. No such penalties were assessed.

At the conclusion of a decision making trial, teams immediately vacated their rooms to make way for the next group. At such times there was some noise and confusion, however, the situation quieted before the next trial began. The student assistants monitored the scene and non-participants were asked to stay clear of the area during decision making periods.

With the exception of the previously described timed phases, the activities of the teams were unsupervised. Within the already noted restrictions, each team allocated its own time. Monitoring was done only when a member left his group. Group leaders with questions were channeled to the experimenter's office which was located on the same floor.

Other considerations

To eliminate some of the excessive variation that would have occured with a freely fluctuating forecast, the growth

of the market was set at a constant four percent per quarter. The constant growth rate was communicated to the teams by means of the "forecast" found at the top of each decision form (See Appendix D). The four percent growth rate continued for all twelve trials.

The significance level was set at .05 for all hypotheses. The .05 level was chosen instead of the .01 level or the .001 level because of the exploratory nature of this research and because of the expected lack of control incurred by the use of the simulation game. All levels of significance will be reported but only those results meeting the .05 criteria will be reported as significant support.

Earlier exploratory research conducted prior to the running of this experiment indicated that there was no significant relationship between the Mach V instrument and intelligence. A slight but non-significant negative correlation was found between the subjects' quality point average and the Mach V instrument. Both of these findings generally support those of Christie and Geis.[72]

Operational hypotheses

The operational hypotheses can be conveniently divided into two categories. The first category is primarily concerned with changes in the external environment while the

second category is primarily concerned with changes in the internal environment caused by changes in leadership. Changes in leadership disrupt the role sets and role expectations which have previously been established by the groups. It can be said that the first category of hypotheses is concerned with the relative differences in productivity as the high and low Mach groups adapt to change in the external environment. The second category measures the differences and the change in the differences in relative productivity as homogeneous and heterogeneous groups adapt to changes in the internal environment following a change of leaders.

HYPOTHESIS I. The mean productivity will be significantly higher for homogeneous high than for homogeneous low Mach groups.

HYPOTHESIS II. The differences in productivity between homogeneous high and low Mach groups will be greater for each subsequent period.

HYPOTHESIS III. Average productivity for all Mach groups will decline for that period following a change of leaders.

HYPOTHESIS IV. Mean productivity is higher for high Mach follower groups than for low Mach follower groups for those periods following a change of leaders.

HYPOTHESIS V. Mean productivity of groups receiving high Mach leaders is greater than that for those receiving low Mach leaders for those periods following a change of leaders.

HYPOTHESIS VI. The differences in the productivity of low Mach follower groups receiving high Mach leaders and high Mach follower groups receiving low Mach leaders is expected to narrow over time following a change of leaders.

HYPOTHESIS VII. The differences in productivity between high and low Mach follower groups is expected to narrow over time following a change of leaders.

HYPOTHESIS VIII. The differences in productivity between high and low Mach led groups is expected to narrow over time following a change of leaders.

HYPOTHESIS IX. Mean productivity will be greater for heterogeneous Mach groups than for homogeneous Mach groups following a change of leaders.

Statistical tools

Two statistical tools are needed to test the aforementioned operational hypotheses. First, a tool is required to perform an analysis of means through the individual comparison of means and for this purpose a t-test is used.[73] Second, a time related measure is needed to measure the increasing or decreasing rank of differences in productivity. For this purpose, the Jonckheere test is used. The Jonckheere test checks for the significance of the relationship between n rankings and k ranked categories. A detailed explanation of these tests can be found in Appendix E. The use of the non-parametric Jonckheere test was predicated by the lack of a suitable parametric test. The Jonckheere test does a pairwise comparison for each succeeding piece of data with all other subsequent pieces of data so that each succeeding piece of data can be compared to all following pieces of data. The rank order of the data can thus be determined.

Summary

This chapter was concerned primarily with operationalizing the basic theoretical approach and then testing it. Operational definitions were given and the design of the research was discussed. Having thus prepared the reader, the operational hypotheses were stated followed by a brief

discussion of the statistical procedures to be used in testing these hypotheses.

Two problems basic to most forms of organization were operationally stated in testable form. These problems were environmental and socio-emotional change. It was hypothesized that high Mach groups would deal most effectively with environmental change but that heterogeneous Mach groups would be more effective in dealing with socio-emotional change.

The hypotheses concerned with the increasing or decreasing differences in productivity were primarily concerned with isolating uncertainty which is hypothesized to be the differentiating factor in the competitive advantage of high Mach groups and heterogeneous groups.

CHAPTER IV

RESULTS AND CONCLUSIONS

The purpose of this chapter is to analyze and discuss the results of testing the relationship of the Mach personality and situational variables to group productivity. The statistical methods used in testing the hypotheses are described and the conclusions of the analysis are stated.

For the purposes of illustration, a tabular presentation of the means, standard deviations, and the resulting t ratios are given for each hypothesis involving a comparison of means. The resulting level of significance accompanies each presentation. Where the Jonckheere test is used, the "Z" ratio is similarly illustrated accompanied by the appropriate level of significance. Where appropriate, graphs are used to illustrate the actual data.

The order of presentation to be followed throughout the chapter is: (1) the hypotheses; (2) a short summary of the pertinent theory; (3) the statistical tools and the testing methods; (4) a tabular presentation of the results; and (5) the conclusions.

The Mach dimension and group productivity

The hypotheses are designed to evaluate the effect of the Mach dimension on group productivity. Both the effect

of personality variables and of situational variables are studied. An attempt is made to assess the effect of the Mach of the leader and follower on group productivity. Finally, the effect of a change of leaders is measured.

The first hypothesis is concerned with the expected competitive advantage of the high Mach.

Hypothesis I. Mean productivity will be significantly greater for high than for low Mach groups.

Christie and Geis's theory suggests that the high Mach's personality characteristics of emotional detachment, cognitive orientation and ego-strength better equip him to deal with the uncertainty generated in a competitive situation requiring the learning of a multitude of tasks.[75] In this situation, the group tasks generate the uncertainty faced by the group. Therefore, the high Mach is expected to be significantly more productive.

The t-test is used to determine whether the difference in performance between high and low Mach groups is significant. This test assumes homogeneity of variance and normality of data. Homogeneity of variance was established through the use of the F-Maximum test for homogeneity of variance.[76] It was not expected that the type 1 error of the decision rule would be seriously affected by the deviation of the population distribution from normality if such a deviation in fact exists.[77]

The test's results for the first hypothesis are given below.

TABLE II

Comparison of the Productivities as Measured by Net Profits/Total Assets Between High and Low Mach Groups

Productivity	Group Composition			
Net Profit/Total Assets	High Mach	Low Mach	t*	p
Mean	1190	961	2.20	.025
Std. Dev.	433	398		

* n=16

Analysis leads to the rejection of the null hypothesis that there is no difference and the acceptance of the alternative hypothesis that productivity is positively related to Mach score. The difference was significant at better than the .025 level which meets the designated significance criterion of .05. The acceptance of the alternative hypothesis and the rejection of the null lends support to the theory that high Machs have a competitive advantage over low Machs in situations involving task related performance where the situational variable of uncertainty exists.

The second hypothesis is concerned with the relative differences in the rate of productivity of the high-low Mach

groups.

> Hypothesis II. The differences in productivity between high and low Mach groups will be greater for each subsequent period.

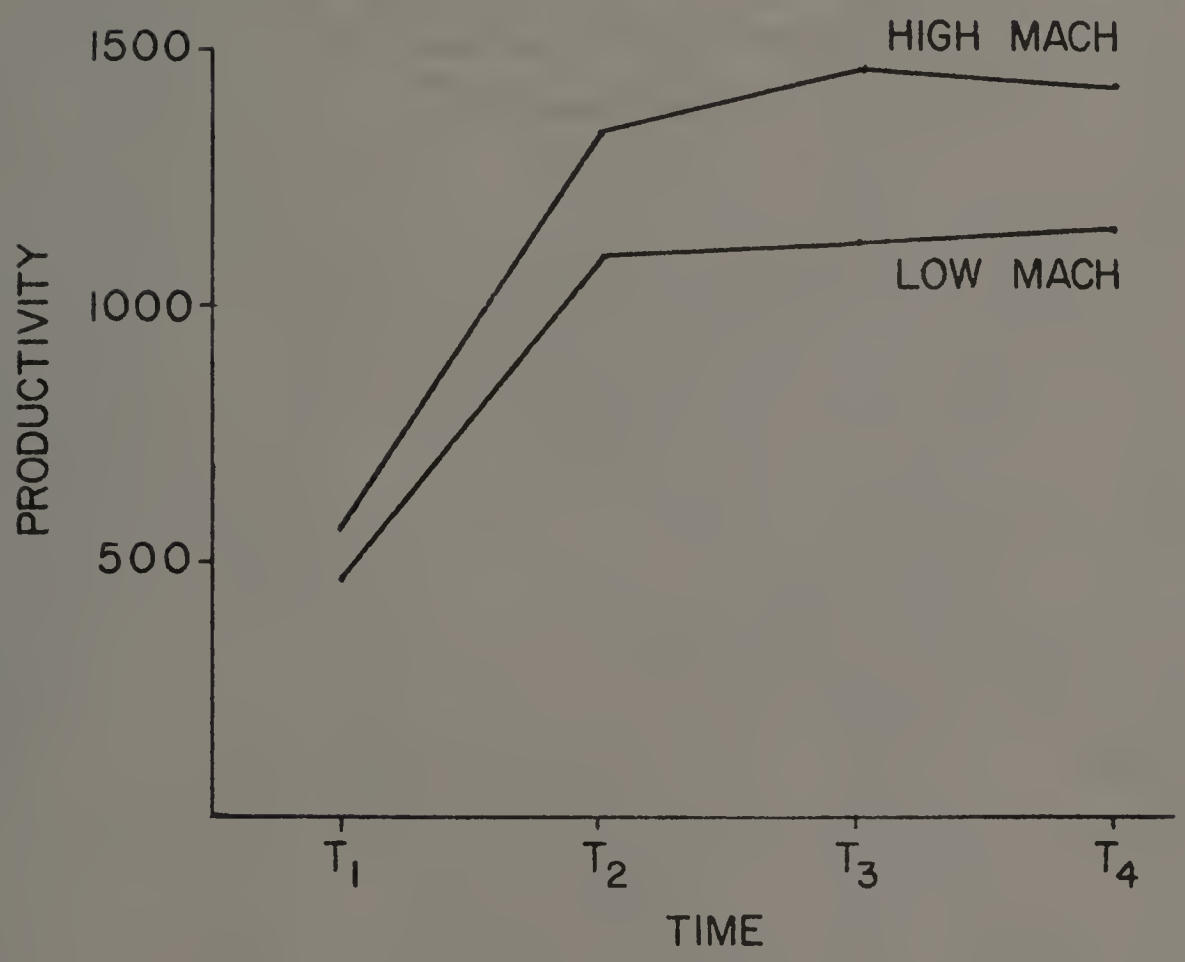
To test this hypothesis, the Johnckheere test is used. This test is especially sensitive where the number of data points are limited.[78] The hypothesized expanding competitive advantage of the high Mach groups is described in terms of the previously explained productivity ratio. The productivity ratio is arrived at by dividing profits by the total assets of each company. This ratio makes possible the comparison of different size companies and also dampens the effect of prior success. The Jonckheere test is used to measure the expected growing differences in productivity. These differences are expected to have an increasing rank order and it is this rank order which the Jonckheere test measures.[79]

The results of the Jonckheere test for the second hypothesis yielded a Z ratio of .023 which was not significant. Therefore, the null hypothesis is accepted while the alternative hypothesis is rejected. Graph #1 shown below illustrates the actual data. An explanation of the implications of this graph will be given in Chapter V.

GRAPH #1

Productivity Data for High-Low Mach

Homogeneous Groupings for Four Periods



Change of leaders

The remaining seven hypotheses examine the effects of a change in group composition and structure caused by a change of leaders. The focus of these hypotheses is primarily on the relative adaptability of the various groups to the socio-emotional obstacles caused by the change of leaders. The level and rate of adaptation is measured by the relative differences in productivity.

The uncertainty created by change of leaders can be

described as internal in contrast to earlier uncertainty which was described as external. By way of explanation, change of structure occurs with the introduction of a new leader while change of composition occurs if the new leader is of the opposite Mach.

The third hypothesis is primarily concerned with the immediate effect of the structural and compositional changes on the level of productivity for all groups.

> Hypothesis III. Average productivity for all Mach groups will decline for that period following a change of leaders.

Ziller, among others, has conducted extensive research on the negative effect of membership change on the productivity of the group. He has also suggested that the intensity of the effect is determined by the status of the member entering or leaving the group.[80] Therefore, the leader, as a high status member, is predicted to have a significant negative effect on the productivity of the group when changed.

The significance of a drop in productivity between periods four and five can be tested for by using a t-test for the significant difference of means. It is hypothesized that the productivity of all groups for period five will be significantly less than that for period four. This test does not take into account the presence of a trend ef-

fect. The productivity of all groups is generally trending upwards. A simple extrapolation from period four would indicate an increase. This expected increase for period five could be tested against the actual productivity for that period and the significance of the difference could then be determined. A more conservative approach matching the productivity of period five against that for period four was decided on. Although the conservative approach tends to understate the significance of the difference, it stands on much firmer statistical ground.

An alternative approach is to test for the significant difference using the Jonckheere test. This test would test for decreasing productivity for all groups going from period four to period five. The Jonckheere test which is generally used to measure increasing order in the data is adapted to measure decreasing order by reversing the order of the data. The significance of this test would also tend to be underestimated. Neither approach yielded statistically significant results. The results for this hypothesis using the t-test are shown on the following page.

TABLE III

Effect of Change of Leaders on Group Productivity as Measured by Net Profits/Total Assets

Productivity	Condition		
Net Profit/ Total Assets	Before Change	After Change	t* p
Mean	1274	1088	1.057 .10
Std. Dev.	280	638	

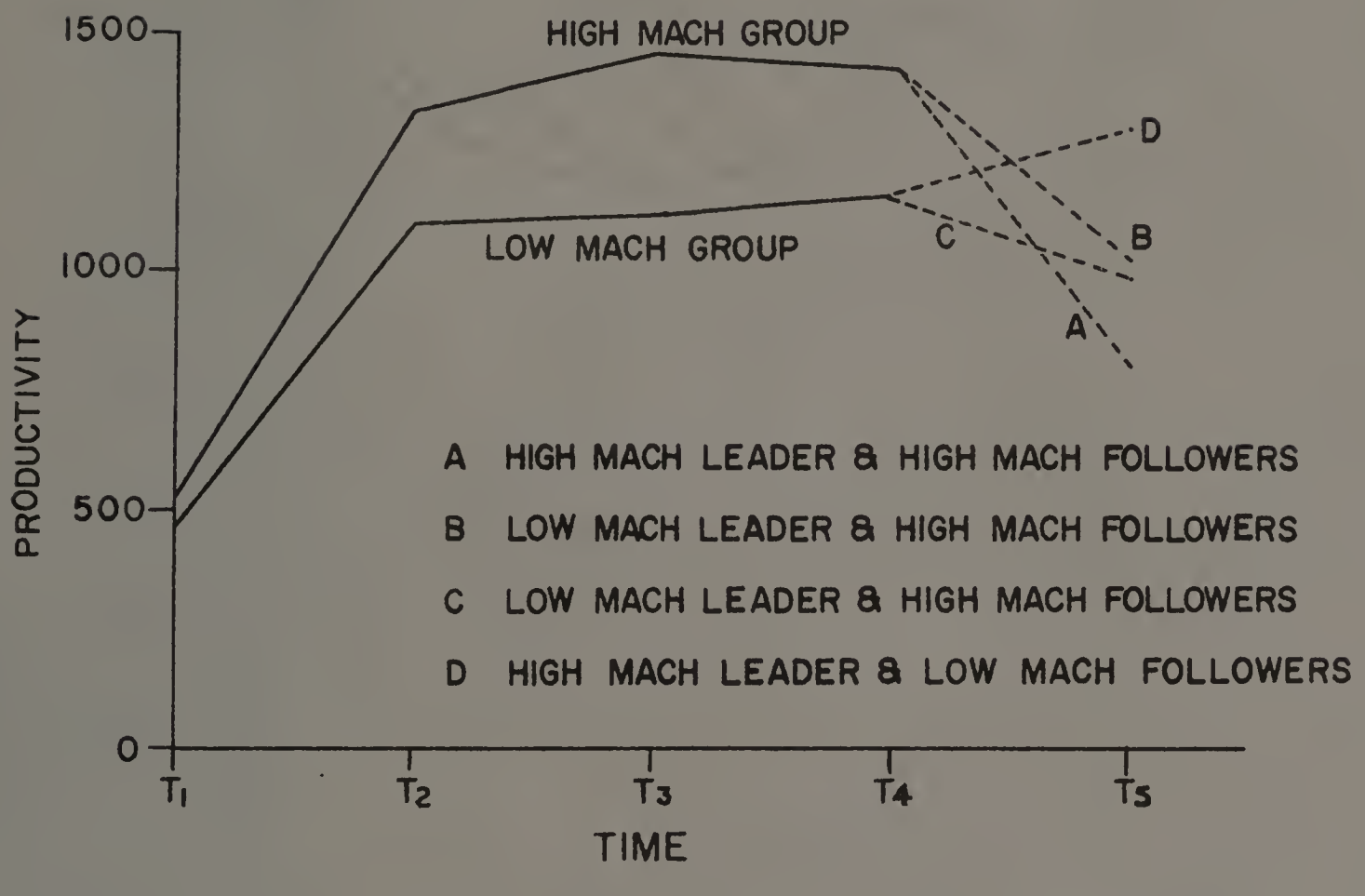
* n=16

The designated significance criterion was not met and therefore, the null hypothesis is accepted while the alternative hypothesis is rejected. However, the results were in the expected direction and will be discussed further in Chapter V.

Graph #2 illustrates the actual data for that period following the change of leaders. The graph is shown on the following page.

GRAPH #2

Productivity Data for Various Mach Groupings Following a Change of Leaders



Hypothesis IV attempts to isolate the effect of the Mach of the followers on group productivity. From the theory of Christie and Geis, it can be hypothesized that those groups with high Mach followers will be more productive than groups with low Mach followers.[81]

> Hypothesis IV. Mean productivity is higher for high Mach follower groups than for low Mach follower groups for those periods following a change of leaders.

A t-test is used to test the significance of the difference of the means of high-low Mach follower groups. This test compares the average productivity for those periods following change of leaders. It involves periods six through twelve.

TABLE IV

Effect of the Follower on Group Productivity as Measured by Net Profit/Total Assets

Productivity	Group Composition			
Net Profit/ Total Assets	High Mach	Low Mach	t*	p
Mean	1615	1450	1.47	.10
Std. Dev.	280	638		

* n=112

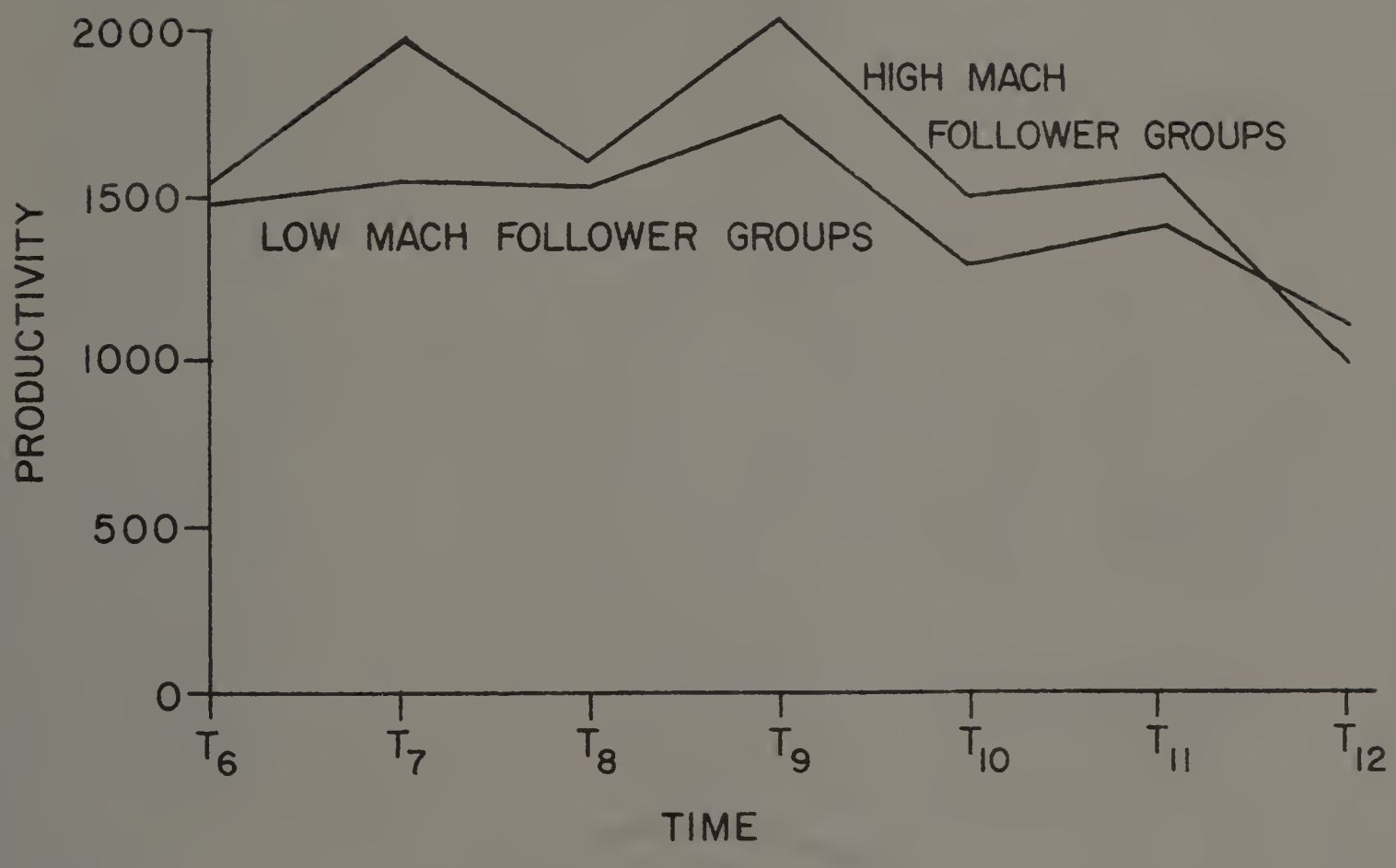
The results of the test do not meet the designated significance criterion. Therefore, the null hypothesis is accepted while the alternative hypothesis is rejected. However, the results of the test were in the predicted direction and will be discussed further in Chapter V.

Graph #3 illustrates the actual data on the competitive relationship between high and low Mach follower groups. The graph is shown on the following page.

GRAPH #3

Productivity Data for High-Low

Mach Follower Groupings



Hypothesis V attempts to isolate the effect of the Mach of the leader on group productivity.

Hypothesis V. Mean productivity of groups receiving high Machleaders is greater than that for groups receiving low Mach leaders for those periods following a change of leaders.

The results of the t-test used to determine the significance of the difference in means are shown on the following page.

TABLE V

Effect of the Leader on Group Productivity

as Measured by Net Profit/Total Assets

Productivity	Group Composition			
Net Profit/ Total Assets	High Mach	Low Mach	t*	p
Mean	1437	1535	-.90	N.S.
Std. Dev.	584	600		

* n=112

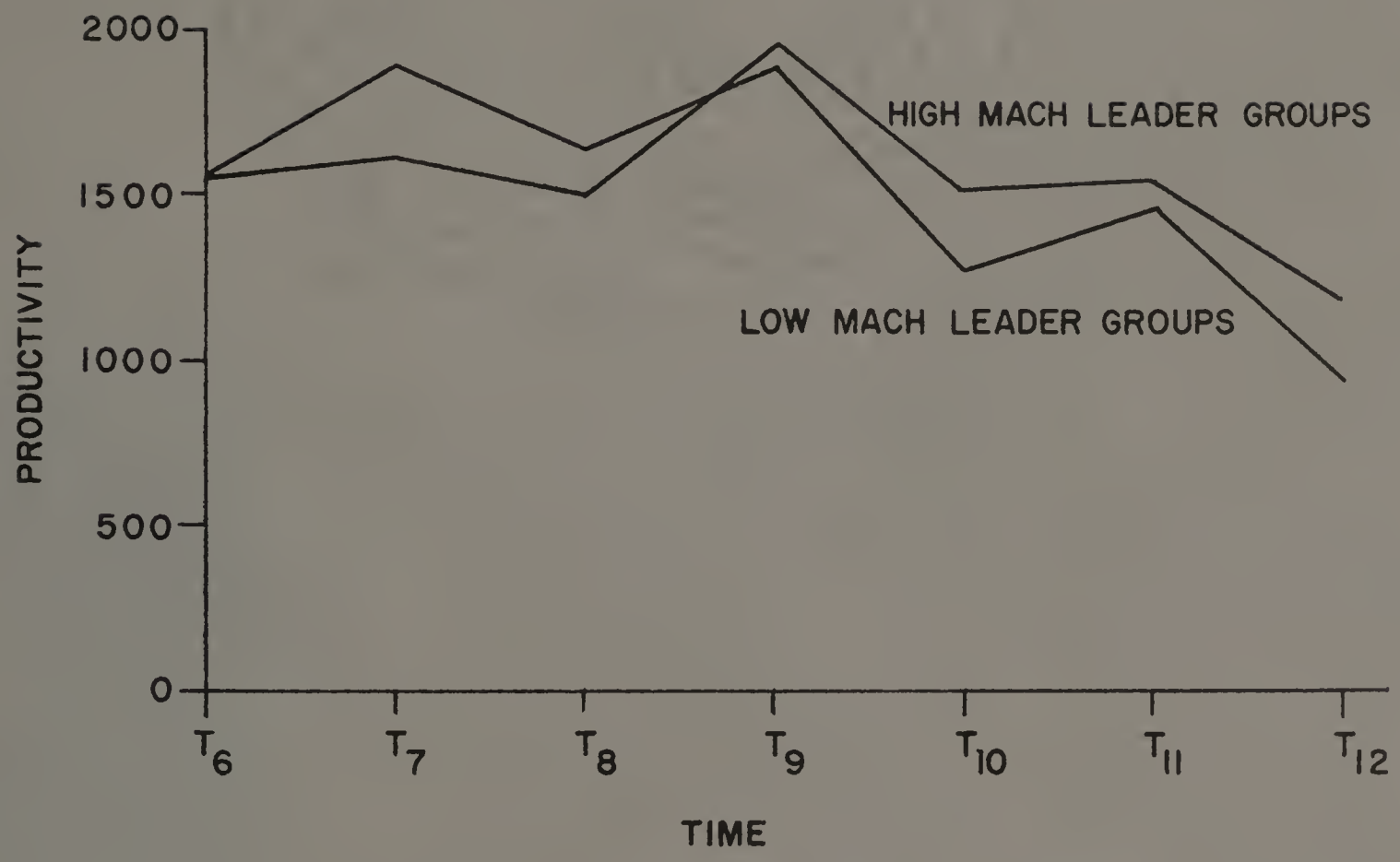
The results of the test do not support the alternative hypothesis at the designated level of significance and therefore, the null hypothesis is accepted while the alternative hypothesis is rejected.

Graph #4 illustrates the actual data on the competitive relationship between high-low Mach led groups, and is shown on the following page.

GRAPH #4

Productivity Data for High-Low

Mach Leader Groupings



Isolating uncertainty

The next three hypotheses are concerned with isolating the situational variable of ambiguity or uncertainty. The Christie and Geis theory maintains that the competitive advantage of the high Mach depends to a large extent on the situational variable of uncertainty.[82] Therefore, learning, through repeated trials of the simulation game, can be expected to reduce or eliminate uncertainty and thereby reduce or eliminate the competitive advantage of the high

Mach. This reduction of uncertainty is expected to result in the convergence of productivity functions.

Hypothesis VI is primarily concerned with the reduction of the productivity gap between heterogeneous groups.

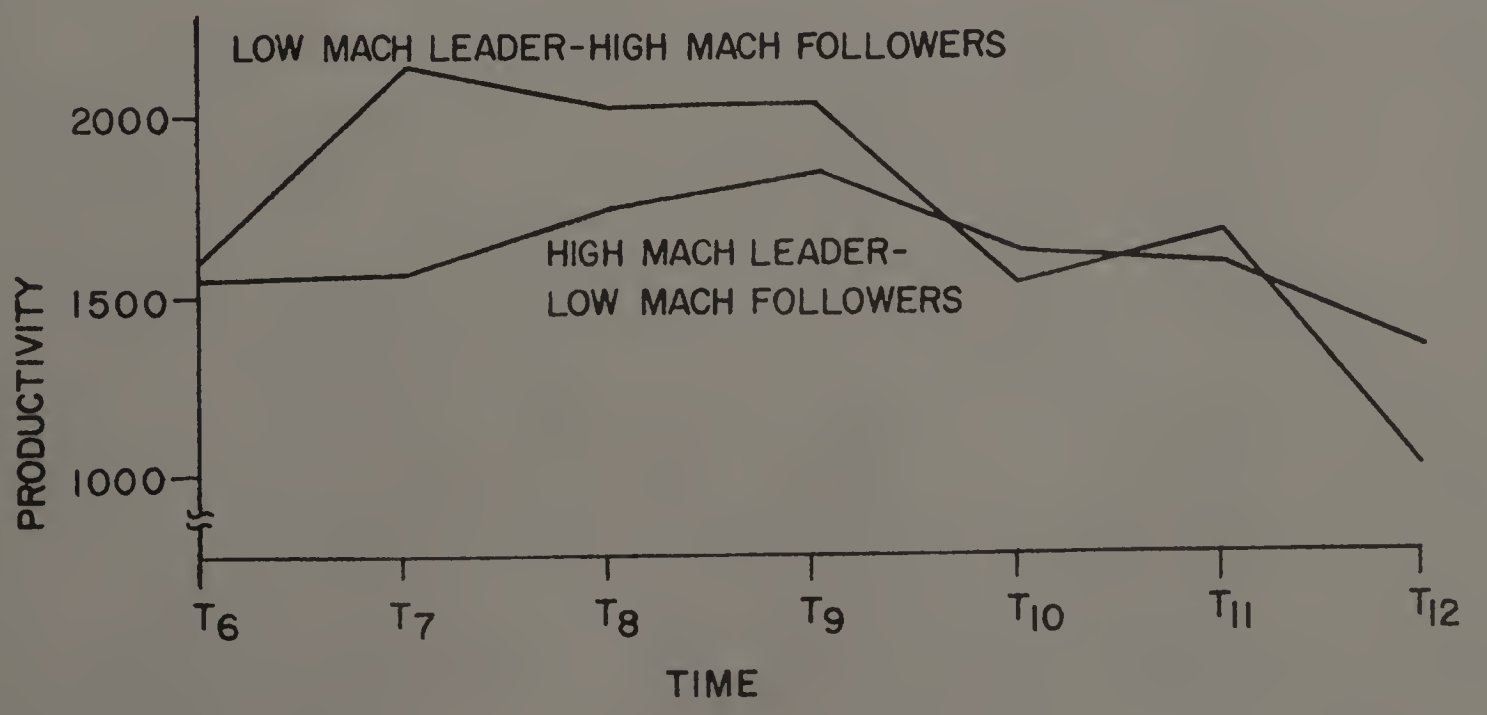
> Hypothesis VI. The differences in the productivity of low Mach follower groups receiving high Mach leaders and high Mach follower groups receiving low Mach leaders is expected to narrow over time following a change of leaders.

The results of the Jonckheere test for the sixth hypothesis yielded a Z ratio of 1.10 which was not significant but was in the predicted direction. Therefore, the null hypothesis is accepted while the alternative hypothesis is rejected. Graph #5 illustrates the actual data and is shown below.

GRAPH #5

Productivity Data for

Heterogeneous Groupings



Hypothesis VII attempts to isolate the effect of the Mach of the followers on the group's ability to overcome uncertainty and reduce the productive gap.

> Hypothesis VII. The differences in productivity between high and low Mach follower groups is expected to narrow over time following a change of leaders.

The theory of Christie and Geis suggests that the differences in productivity between high and low Mach follower groups will diminish as the uncertainty is reduced through repeated trials.[83]

The results of the Jonckheere test for the seventh hypothesis yielded a Z ratio of .352 which was not significant. Therefore, the alternative hypothesis is rejected while the null hypothesis is accepted.

Hypothesis VIII attempts to isolate the effect of the Mach of the leaders on the group's ability to overcome uncertainty and to reduce the productivity gap.

> Hypothesis VIII. The differences in productivity between high and low Mach led groups is expected to narrow over time following a change of leaders.

The theory of Christie and Geis suggests that the differences in productivity between high and low Mach led groups will diminish as the uncertainty is reduced through re-

peated trials.[84]

The statistical results of the Jonckheere test for the eighth hypothesis yielded a Z ratio of -1.76 which was not significant. Therefore, the alternative hypothesis was rejected while the null hypothesis was accepted.

Hypothesis IX is primarily concerned with the competitive relationship between heterogeneous and homogeneous groups.

> Hypothesis IX. Mean productivity will be greater for heterogeneous than for homogeneous Mach groups following a change of leaders.

Bales and Borgotta theorize that decision making groups need both task and social leadership and that these needs are best filled by different individuals.[85] The Mach theory of Christie and Geis suggests that the high-low Mach dimension may also discriminate between task and social orientations with high Mach corresponding to task orientation and low Mach corresponding to social orientation.[86] Therefore, it can be implied from the aforementioned theories that groups containing both Machs are more productive.

TABLE VI

Comparison of the Productivities as Measured by Net Profits/Total Assets Between Heterogeneous and Homogeneous Groups

Productivity	Group Composition			
Net Profit/ Total Assets	Heterogeneous	Homogeneous	t*	p
Mean	1621	1335	2.67	.005
Std. Dev.	565	635		

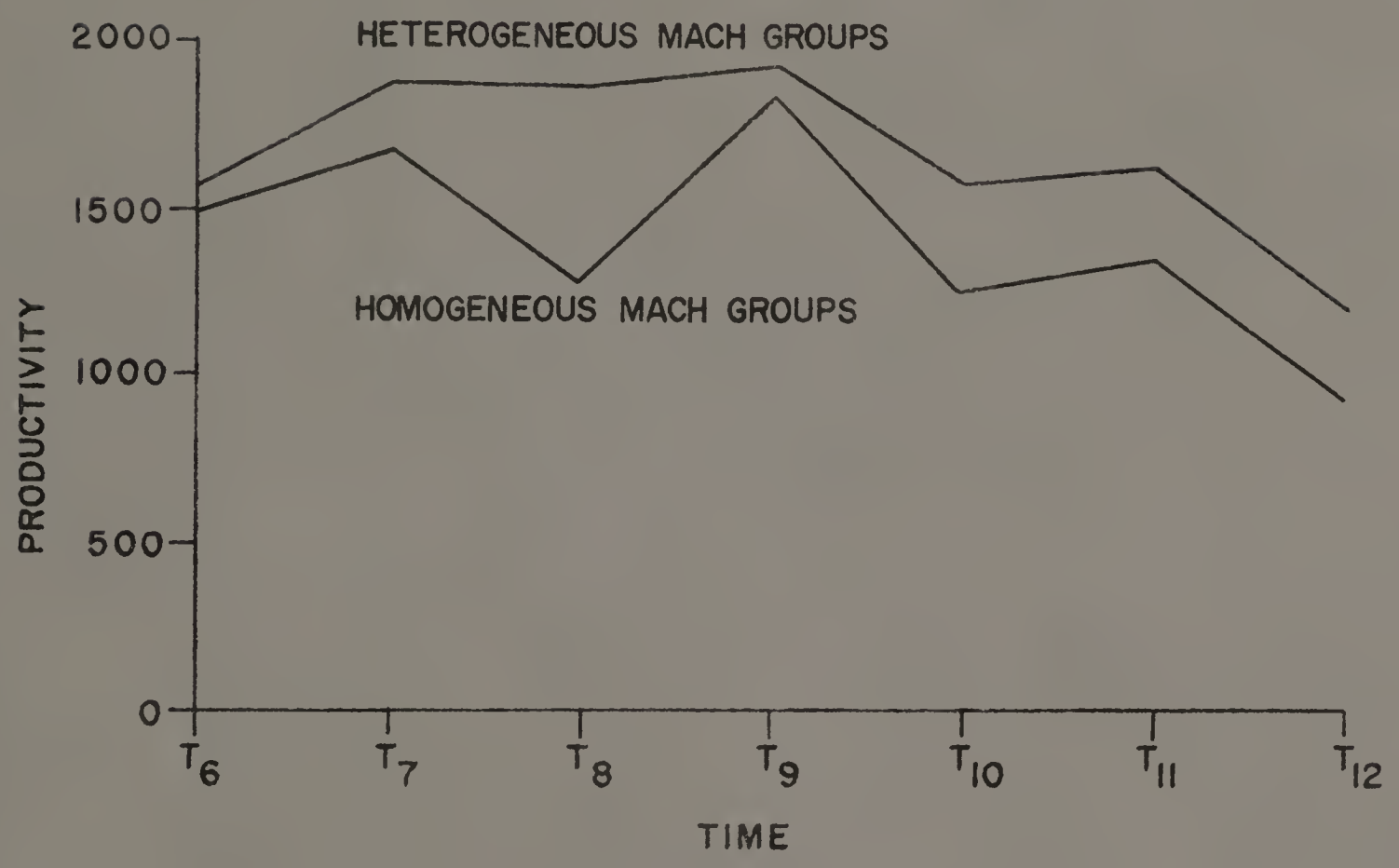
* n=128

The statistical results support the alternative hypothesis and reject the null hypothesis. Graph #6 illustrates the actual data and is shown on the following page.

GRAPH #6

Productivity Data for Homogeneous

and Heterogeneous Groupings



Summary

Statistically significant support was found for the theory suggesting that homogeneous high Mach groups are more productive than homogeneous low Mach groups and for the theory suggesting that heterogeneous groups are more productive than homogeneous groups. The remaining hypotheses were not statistically supported. The results were in the predicted direction for those hypotheses testing the theory that change of leaders has a negative effect on

group productivity; the competitive advantage of the high Mach homogeneous groups increases at an increasing rate immediately after the onset of uncertainty; the Mach of the followers has a significant impact on the productivity of the group; and the reduction of the situational variable of uncertainty is reduced and thereby reduces the productive gap between groups following a change of leaders. No support was found for the remaining hypotheses. A tabular summary of the research results is shown on the following page.

TABLE VII

A Summary of the Research Results

Hypotheses	Results
I	The superior productivity of the high Mach groups over the low Mach groups was significantly supported.
II	Growth in the differences in productivity between high and low Mach groups was not significantly supported.
III	Significant support was not achieved for the predicted negative effects of a change of leaders on productivity but a tendency in that direction was noted.
IV	Significant support was not achieved for the predicted positive relationship between the Mach of the follower and productivity but a tendency in that direction was noted.
V	Significant support was not achieved for the predicted positive relationship between the Mach of the leader and productivity but a tendency in that direction was noted.
VI	Significant support was not achieved for a decrease in the growth of the differences in productivity between heterogeneous groups but a tendency in that direction was noted.
VII	Significant support was not achieved for the decrease in the growth of the differences in productivity between the high and low Mach follower groups.
VIII	Significant support was not achieved for the decrease in the growth of the differences in productivity between high and low Mach led groups.
IX	The superior productivity of the heterogeneous Mach groups over the homogeneous Mach groups was significantly supported.

CHAPTER V

DISCUSSION

The purpose of this chapter is to discuss the results of this study. A synthesis of the research results with relevant group theory and the theory of Christie and Geis suggests some modifications to these theories and some potentially fertile avenues for future research. The limitations and values of the study will also be explored.

A further examination of the results

This chapter will further examine the results of the research with the intent of explaining in greater detail some implications not mentioned in the previous chapter. Several of the hypotheses which were not significantly supported but provided results in the predicted direction had some interesting implications which should not be ignored. Other hypotheses yielded important considerations for future research. Therefore, the first part of this chapter will cover those aspects not previously covered but believed essential to a more complete understanding of the results and to more fruitful future research.

The first hypothesis maintained that the high Mach homogeneous groups were more productive than the low Mach homogeneous groups. Analysis is consistent with and

supports the Christie and Geis theory which maintains that the personality characteristics of the high Mach enable him to make decisions more effectively under conditions of uncertainty.[86] His characteristic of emotional detachment frees him from emotional commitment to his own views and the views of others. This emotional freedom enables the high Mach to cognitively evaluate each decision situation without emotional distortion. On the other hand, the low Mach becomes emotionally distracted and fails to seize upon the realities of the decision making situation. Furthermore, the high Mach is more persuasive in selling his viewpoint but more resistant to the persuasion of others. In summary, the previously mentioned personality characteristics of the high Mach when combined with the condition of uncertainty give him a competitive advantage over the low Mach.[87]

The results of the analysis support the Christie and Geis contention that the high Mach is the more effective decision maker. High Mach groups significantly outproduced low Mach groups. Thus, the theory supporting the competitive advantage of the high Machs can now be extended to include high Mach groups in a competitive situation. Although the analysis was concerned with only the first four periods or trials, the same approximate level of significance was obtained when all twelve periods were included.

The situational characteristics which serve as a catalyst to the high Mach competitive advantage have been previously described by Christie and Geis as face-to-face interaction, latitude for improvisation, and irrelevant affect. Since face-to-face interaction and irrelevant affect are extremely difficult to measure, it was decided that the study would concentrate on latitude for improvisation. Latitude for improvisation can be variously described as uncertainty, ambiguity or lack of structure.

Changes in the internal and external environment of a group loosens the task and social structure of the group creating the uncertainty condition necessary to the successful competition of the high Mach. The business simulation game used in the study provides the environmental change while change of leaders provides the internal change necessary to loosen the structure.

The second hypothesis suggests a growing difference in the relative productivity of the homogeneous high and homogeneous low Mach groups. This hypothesis studies the relationship between the high Mach's personality characteristics, as outlined in Chapter II, and the key situational variable of uncertainty.

The divergence of productivity functions, as illustrated by Graph #2 on page 67 implies an early significant competitive advantage for the high Mach which is expected

to diminish as the number of trials increases. The second hypothesis is concerned only with those periods covering the growth of the competitive advantage.

The Jonckheere test of significance of growth in the ranked productivity differences did not meet the designated significance level and therefore the alternative hypothesis was rejected and the null accepted. However, a simple rejection of the null hypothesis would hide some interesting results. The statistical analysis does not conclusively refute the assumption that uncertainty is a key and discriminating situational condition necessary to the competitive advantage of the high Mach. However, the acceptance of the null does raise the question of the number of trials necessary for the advantage to peak.

From Graph #2, an examination of the actual data reveals that competitive differences in the average productivity of high and low Mach homogeneous groups tripled from the first to the second trial; increased again by one and one-half times for the third trial and then diminished slightly for the fourth trial. The graph supports the contention that the high Mach group enjoys an immediate and growing competitive advantage but points out that the intuitively derived four trial time period extends beyond the peak of the competitive advantage. This delineating of the time period has implications for future research.

By way of further explanation, the failure to achieve overall statistical significance can be attributed to the lack of specific knowledge concerning the number of trials necessary for the advantage of the high Machs to completely develop. Apparently, the number of trials necessary for the group to reestablish its structure after a change is less than anticipated. The effect of interaction through repeated trials acts to speed the reestablishment of group structure and thereby accelerate the return to prior production levels.

The third hypothesis reflects that body of theory best described by Ziller and others which maintains that the disruptive effect of a newcomer to a group results in a temporary decline in productivity.[88] This hypothesis failed to meet the designated significance level which lead to the rejecting of the alternative hypothesis and the acceptance of the null. However, the results were in the predicted direction.

The later theory of Ziller qualifies his earlier position on the negative effects of the newcomer on productivity by adding the consideration of the present status of the group and the status of the newcomer.[89] The theory of Bales and Borgatta further modifies the theory of the newcomer by suggesting that such a change might be beneficial if the newcomer brought skills not already possessed by the group.[90]

For the purposes of this research, it must be remembered that the change of leaders resulted in both homogeneous and heterogeneous groups. The disruptive effective of the newcomer was moderated in heterogeneous groups. Therefore, it can be said that the effect of the newcomer on the group is negative if his abilities do not complement those of the group. Further his status and the status of the group are also important moderating factors.

More specifically, high Mach groups experienced greater success prior to the exchange of leaders. Therefore, those low Mach groups receiving the generally more successful high Mach leaders can be theorized to be more receptive to the newcomer resulting in less disruption and therefore a smaller decrease in productivity. In addition, the mixed composition groups are more productive, further reducing the anticipated loss of productivity by offsetting the disruptive effects of the newcomer entirely.

Graph #2 on page 67 illustrates the actual data for that period following a change of leaders. Analysis shows that three of the four major groupings showed a decline in productivity and one grouping showed an increase. Further interpretation of the data suggests that the low Mach follower grouping receiving the high Mach leader indicated an increase in productivity because the new leader was high in status having come from a generally more successful high

Mach group and his abilities complemented those of the low Machs.

On the other hand, the high Mach follower groupings were enjoying a competitive advantage prior to a change of leaders. Their subsequent loss of productivity can be attributed to their rejection of a change of leaders that could jeopardize a winning combination. The negative effects of the rejection are partially offset for the high Mach follower grouping receiving the low Mach leaders because of the effect of complementary abilities.

In summary, it can be said that the relationship of a change of leaders to group productivity is not a simple one. The status of the new leader and of the group must be taken into consideration along with the effect of the changing of group composition and member complementarity.

There are suggested theoretical modifications to the effect that homogeneous high Mach groups experience the greatest drop in productivity when receiving a high Mach leader and therefore the negative affects described by Ziller among others, most clearly pertains to this grouping. However, the disruptive effects of a change of leaders is not clearly identifiable for other groupings because of the offsetting factors of status and complementarity.

The fourth hypothesis attempts to isolate the effect of the Mach of the followers on group productivity. Accord-

ing to the theory of Christie and Geis, the high Mach follower groups can be expected to outproduce the low Mach follower groups.[91] The results did not significantly support this contention. Therefore, the alternative hypothesis was rejected and the null hypothesis was accepted. However, the results were in the predicted direction.

Graph #3 on page 69 indicates that the high Mach follower groups were more successful for every period but the final one. The gradual decrease in the productivity gap between the high and low Mach follower groups was correctly predicted using the relationship between Mach and uncertainty. In other words, the productive advantage of the high Mach follower group is expected to diminish and ultimately disappear as uncertainty decreases. Again, as with the second hypothesis, the intuitive estimation of the number of trials was too large. By eliminating trial periods six and twelve, the analysis produced results approaching the designated level of significance. The elimination of period six can be justified by the need for a longer period of recovery following the traumatic effects of a change of leaders. The number of trials can be arbitrarily ended at eleven because the elimination of the productive gap occurs at that point. It must be remembered that no data existed on the number of trials necessary for groups to eliminate uncertainty by tightening their structural framework and

that the use of seven trial periods was intuitive. Evidently, the group's effort to restructure is delayed longer than anticipated by a change of leaders but proceeds at a faster than anticipated pace thereafter. Therefore, it is suggested that the number of trial periods be adjusted in any future research.

The fifth hypothesis is primarily concerned with the effect of the Mach of the leader on productivity. The statistical results do not support the alternative hypothesis and therefore, the null is accepted. The results suggest that the opposite of the hypothesized relationship may be true. Two conflicting tendencies underly the results and they should be explored.

The unexpected results of the fifth hypothesis prompted further analysis. From this analysis, it was found that the differences in productivity between the high and low Mach led groupings show an almost cyclical tendency with the data functions reversing twice. Graph #4 on page 71 illustrates this tendency.

Another analysis viewing the data from a different orientation (i.e., in terms of heterogeneous and homogeneous groupings) indicates a tendency towards convergence between heterogeneous groupings and a tendency towards divergence between homogeneous groupings. The divergence tendency of the homogeneous groupings is more pronounced during

the earlier trial periods while the convergence tendency of the heterogeneous groupings is more pronounced during the later trial periods. These tendencies account for the conflicting results obtained. The exact meaning of this conflicting tendency in terms of Mach theory are not readily apparent to the author but merit further attention in future research.

The attempted isolation and measurement of the variable of uncertainty is further attempted in hypotheses VI, VII, and VIII. These hypotheses are primarily concerned with the relationship of the high-low Mach follower groups, high-low Mach leader groups and heterogeneous groups to the situational variable of uncertainty. These relationships will serve to delimit uncertainty.

The sixth hypothesis is concerned with the competitive relationship of the heterogeneous groups. The statistical results do not support this hypothesis but are in the predicted direction. Convergence tendencies are indicated by the graphical presentation on page 71. Again, the intuitive estimate of the number of periods necessary for the elimination of uncertainty and thereby the differences in productivity was inaccurate. The period necessary to reestablish group structure and productivity was less than anticipated. Future research should include this consideration.

Although the statistical results do not support this hypothesis at the designated level, they do mark the first attempt to delimit a situational variable. Christie and Geis found it difficult to separate the effects of the situational variables and did not attempt separate situational measures. In fact, their approach was to count the number of studies in which the situational variables appeared, and whether they appeared alone or in concert with either or both of the other variables. For example, their studies revealed that in thirty-six of fourty-four cases, face-to-face interaction and latitude for improvisation were jointly present or not present; in thirty-five cases face-to-face interaction and irrelevant affect covaried; and in twenty-six cases latitude for improvisation and irrelevant affect covaried.[92] In none of their studies was the effect of one of the situational variables studied. Although the isolation of this variable was not successful, it should be remembered that the negative relationship between the number of trials and the gap in productivity tends to limit the number of trials during which a competitive advantage can be studied. In other words, the time period necessary for effective restructuring of the group was consistently overestimated. This excess of time has the effect of diluting significance. Thus, the importance of the amount of time necessary for the group to

effectively restructure itself as a consideration for future research must be emphasized.

The seventh hypothesis is primarily concerned with the relationship of the Mach of the follower and the decrease of the differences in productivity between high and low Mach follower groups. Statistical results were not significant and therefore, the alternative hypothesis was rejected and the null hypothesis accepted. However, the results were in the predicted direction. The prediction of convergence based on theory of Christie and Geis was not supported. Again, as in earlier hypotheses attempting to measure convergence, the intuitive estimate of the number of trial periods necessary to measure convergence was too large. In addition, the variance of the decisions for this hypothesis was greater than anticipated. This variance could be dampened in future research by the use of more "dummy" teams. Such a structural modification would reduce the impact of an individual team on the other teams in a decision making world thereby reducing the variance.[93]

The eighth hypothesis is primarily concerned with the relationship between the Mach of the leader and the decrease in the differences in productivity between high and low Mach leader groups. The statistical results did not support this hypothesis and therefore the alternative hypothesis was rejected and the null accepted. Again, as in

Hypothesis V, the failure of this hypothesis to achieve significance lies primarily with the underlying conflicting tendencies towards divergence and convergence of the homogeneous and heterogeneous groupings.

The ninth hypothesis is primarily concerned with the comparative advantage of the heterogeneous groups. The results for this hypothesis were statistically significant leading to the acceptance of the alternative hypothesis and the rejection of the null hypothesis. The results support the positive relationship of the heterogeneous Mach grouping to productivity.

This hypothesis supports the relationship of the theories of Bales, Borgatta, Homans, Cattell and Stice and Collins and Guetzkow, outlined in Chapter II, and Christie and Geis's Mach concept. The link between these previously mentioned theories and that of Christie and Geis is the task orientation of the high Mach and the socio-emotional orientation of the low Mach.[94]

These earlier theories emphasized the task and socio-emotional needs of the group. The task needs of the group result from survival demands made by the environment. The socio-emotional needs are theorized to be partly dependent upon the needs of the individual members and on the structure and composition of the group. In addition, theory states that both task and socio-emotional leadership are

necessary for stable and productive groups. As was theorized in Chapter II, task and socio-emotional leadership positions are thought to be best filled by different people.

As was previously stated, the personality characteristics of the high and low Mach closely parallel those of the task and socio-emotional leader. Prior research also indicates greater productivity for those groups having both task and socio-emotional leadership. Although support was found earlier for the superior productivity of homogeneous high Mach (task oriented) groups, research indicates that the preoccupation of the task leader with task related activities leads to the frustration of the socio-emotional needs of the group's members. This frustration if not alleviated will ultimately result in the deterioration of morale and group performance. Heterogeneous Mach groups, containing both task and socio-emotionally oriented leaders, satisfy more of the members needs leading to increased productivity.

A SYNTHESIS

Group theory

For the most part modifications and extensions of existing theory are based on a synthesis of the relevant

group theories, the theory of Christie and Geis, and the results of this research. It was felt that these modivications and extensions would clarify the relationship of Mach to group decision making in a competitive environment. To preface the discussion of the modifications and extensions, a short review of the aforementioned theories is necessary. A summary of the group theories can be found in Table #1 on page 19. The summary includes the Sherif and Sherif, Argyris, Gibb, Collins and Guetzkow, Cattell and Stice, Fiedler, Homans, Bales, Borgatta and Kelly.

The theory of Sherif and Sherif illustrating the evaluation of task leadership in competitive groups and the resulting task superiority in those groups achieving early and effective task leadership was supported. The above memtioned authors were primarily concerned with the evaluation of task leadership in a competitive environment and did not pay special attention to situational or personality characteristics.[95] This author's research adds a situational and personality dimension to the task research of Sherif and Sherif. In other words, the desire of the person to act to structure the environment and the environment itself become important considerations. It was shown from the results of this author's research that task oriented groups achieve greater productivity in a competitive en-

vironment. However, the greatest productivity was achieved by groups having a combination of task and socially oriented members within the same group.

Argyris' concept of "reality centered leadership" was generally supported but not without some important modifications. Argyris portrayed the reality centered leader as one who was able to choose that style of leadership best enabling him to complete the task.[96] In other words, Argyris' leader was capable of choosing a task or social style of leadership when that style offered the best means of goal achievement. The results of the research of Bales and Borgatta conflict with Argyris' concept. Bales and Borgatta maintain that the task and social leadership roles are best filled by different people because those attributes necessary for successful task leadership may exclude the kind of behavior necessary for effective social leadership.[97] The results of this research tend to support the theory of Bales and Borgatta thereby modifying Argyris' theory to the extent it acknowledges that the leader would be more effective if he could play both the task and social role. However, the leader that can assume both of these roles is a rarity and therefore, the task and social roles are generally filled by different people.

Gibb's theory that the leader must contribute to group locomotion[98] was generally supported. However, locomotion

was extended to include progress in both the task and social spheres. Task groups were found to be significantly more productive than social groups. However, the combination of task and social (i.e., high and low Mach) was found to be significantly more productive than either. Therefore, Gibb's theory can now be modified to include "locomotion" in the social sphere so that total group progress was recognized by both spheres and structures the group to provide both types of leadership. It is implied by the results of this research that the group has both task and social needs and that greater need satisfaction leads to greater productive effort.

The Collins and Guetzkow theory contending that the group had both task and social needs and that the task and social satisfaction received by the group motivated productive behavior was generally supported.[99] The emphasis on goal orientation in a competitive environment where the more effective group is task or goal oriented, was supported by the research which indicated the productive superiority of high Mach groups over low Mach groups. However, the most productive groups also contained socially oriented leadership adding support to the Collins and Guetzkow theory specifying the necessity of both types of satisfaction and both types of leadership if the group was to be more effectively motivated.

Cattell and Stice found that the personality variable of "deliberate will control" differentiated between leaders and non-leaders. They concluded that the determination, stability of purpose, and the organizational precision associated with deliberate will control enables a leader to see his decisions through and to organize the group with a high degree of consistency. All of which contributes to greater group productivity.[100] Cattell and Stice's concept of will control corresponds closely with Christie and Geis's high Mach. The high Mach possesses personality characteristics of emotional detachment, cognitive orientation, and resistance to social pressure which in effect are remarkably similar to those describing "deliberate will control." The superior productivity of the high Mach when competing against the low Mach tends to support the Cattell and Stice theory. The Cattell and Stice theory must be extended to include the group structure and then modified to include social needs.

Fiedler's concept of the "psychologically distant leader" and his later work on "leadership effectiveness" describes both personality and situational characteristics necessary for greater productivity.[101] His earlier theory on psychological distance which is similar to Argyris' "reality centered leader", is somewhat modified by his later work which concluded that the leader's effectiveness is de-

termined in part by his leadership style and by the situational factors existing in the group. He found that certain leadership styles were more effective in certain situations.[102] A synthesis of both of his theories would portray a leader who could adapt his style to the situation by varying his psychological closeness or distance. Such a concept would receive support from the success of the high Mach in a task situation because the high Mach is noted for his "coolness" in interpersonal relations and his success in a competitive situation requiring such cool detachment and goal orientation supports Fiedler's psychologically distant leader and incorporates his newer emphasis on situational factors. However, the results of the research would indicate a modification of Fiedler's research to include the need for both task and social leadership (i.e., both psychologically distant and psychologically close leadership) to varying degrees in various situations.

Homans stresses the group's need for both task and social satisfaction in order to deal more effectively with the external environment and therefore to be more productive.[103] This theory coincides with those of Bales, Borgatta, and Collins and Guetzkow. Homans' theory is supported by the results of Hypothesis IX which indicated the productive superiority of heterogeneous groups. Bales' theory which is similar to Homans' was supported for the

same reasons and by the same research results.[104] Bales' theory maintaining the need for both task and social leadership roles filled by separate individuals was supported by these results.

Mach theory

The Mach theory of Christie and Geis examines the Mach variable in terms of personality, situations and tactics. The Mach personality is arbitrarily divided into two categories; those high in Mach characteristics and those low in Mach characteristics. The high Mach is characterized as cool (not distracted by irrelevant affect); and oriented towards self-defined goals, task success, information processing, and a cognitive approach to problem solving situations. On the other hand, the low Mach is characterized as open (susceptible to affective involvement), and oriented towards interaction process, emotional distractibility and immediate emotional reaction to problem cues and responses.[105]

The personalities of the high and low Machs determine the tactics to be used in a given decision making instance but these tactics are also dependent upon the situation. For example, the high Mach, when operating in a decision situation which is loosely structured, can be expected to use tactics concerned primarily with limits testing, initiation and control of structure, and instrumental exploitation

of resources. Loose structure is defined in terms of the lack of predefinition of the exact role behavior of the participants, the lack of predefinition of the means to achieve the goals, and considerable need for improvisation. Loose structure can also be described as the latitude for improvisation caused by decision making uncertainty.[106]

The low Mach operates more efficiently in a "highly structured' situation where his tactics are to work within the given system and to make an effort to perform well. Highly structured can be defined in terms of clear predefinition of role and reward structure, clear predefinition of responsibilities and the means to achieve these goals, and the lack of need for improvisation.

In those instances where the high Mach was required to operate in a highly structured situation, his tactics were to work within the system but to perform perfunctorily or even apathetically. By the same token, when the low Mach was forced to work in a loosely structured situation, his behavior tended to be unsure, impulsive and he tended to accept the structure provided by others.[107]

Two mechanisms were used to loosen structure in this study. The first mechanism involved changes in the external environment managed by means of the changes in the variables of the business simulation game. The second

mechanism made use of Ziller's theory on the disruptive influence of a newcomer by instituting a change of leaders. Both mechanisms tended to loosen group structure. The changing variables of the simulation game had a greater impact on decision making early in the study but this impact lessened as the game progressed and the participants learned or tightened the structure. Change of leaders was meant to loosen the interpersonal structure. However, the impact of the change was expected to lessen as the interpersonal structure was reestablished during subsequent trials.

The competitive advantage of the high Mach in a loosely structured decision making situation was supported by the first hypothesis. However, further attempts to evaluate the impact of structure did not receive statistically significant support from either the second, sixth, seventh, or eighth hypotheses. However, it should be noted that support was in the predicted direction. A general evaluation of the data does reveal that the difference in the mean productivity of high and low Mach groups was greatest when the structure was loosest.

A familiar problem in all groups is the change of membership or leadership. No study of group decision making effectiveness should exclude the potential impact of such a change. Ziller's theory cites the negative effects of

membership change on group productivity.[108] His theory when combined with the Mach theory of Christie and Geis and extended to include the leader of the group predicts a significant decrease in the productivity of all the Mach groupings. This hypothesis did not receive statistically significant support although the support was in the predicted direction. Further examination revealed that the effect of change of leaders is complex and cannot be evenly applied to all groups.

Because groups cannot be expected to be either homogeneous high or low Mach, it was decided to investigate the productivity of mixed Mach or heterogeneous Mach groups. The theory of Christie and Geis outlined in Chapter II does not consider the heterogeneous Mach group. In fact, most of the Christie and Geis theory is concerned with the individual and not the group. Bales and Borgatta do theorize on heterogeneous groups and their concentration on task and social leadership of the group coincides with Christie and Geis's description of the high Mach as task oriented and the low Mach as socio-emotionally oriented. A synthesis of these theories predicts a competitive advantage for the heterogeneous Mach groups. This prediction was significantly supported by the ninth hypothesis. Therefore, the Christie and Geis theory can be modified to state that the high Mach is more productive in loosely structured situa-

tions but that in a group setting the heterogeneous Mach group is more productive than the homogeneous Mach group.

A possibility that was not explored by this study is that the low Mach may be more productive in a highly structured situation. This possibility should be explored in future research.

In summary, the Christie and Geis model was extended by this study to include decision making groups in a competitive environment. The theoretical contention that the high Mach is more productive in a loosely structured situation was supported using the measure of group productivity. The effect of change of leaders on group productivity was examined. Ziller's theoretical contention that a newcomer has a significant negative effect on group productivity was not supported. The relationship of the change of leaders was found to be complex. A synthesis of Mach theory and the theory of Bales and Borgatta predicted superior productivity for heterogeneous Mach groups. This prediction received statistically significant support.

Limitations of the study

There were several limitations to this study. The shortness in duration of the study left several questions unanswered. A study consisting of a greater number of decision periods would have answered the question of the

long term relationship between Mach and productivity. Such a longitudinal study could have traced the competitive relationship of the Mach groupings to indicate if the assumption that once uncertainty was removed there would be only random differences in productivity. These unanswered questions must now remain the subject of future research.

The matching of skills and work related experiences created another limitation. Fortunately, this limitation was partially diminished by the fact that all of the subjects were drawn from a fairly homogeneous business college population and were almost all second semester seniors of comparable educational experience. However, disparities did exist and some thought must be given to the development of a better system for matching the various teams than the randomized approach. The randomized procedure would have been more adequate if the number of groups had been greater.

Doubts exist concerning the appropriateness of the random choice of group leaders. These doubts would be diminished if the number of groups was greater so that the process of randomization could be more complete. The actual leader was not the appointed leader in all groups. However, it can be argued that the same is true of organizataional leadership in general.

The use of Nichols College seniors as subjects creates some doubts as to the generalizability of the results. For

example, generalizing to the real business world on the basis of results obtained from college students presents some rather obvious problems. Such generalization should only be made after considering the source of the results and observing the limitations inherent in such generalizations.

The use of a simulation game presents some problems. The simulation game is designed to create a competitive and interactive situation. However, interaction would confound the results. Steps described in Chapter III had to be taken to eliminate the interactive effects. Careful attention was given to the effect of earlier decisions on the financial structure of the team and its ability to operate effectively. In other words, early success can extend the range. This effect was partly offset by the use of the productivity ratio of profit to total assets. This ratio compensates for size and early success.

Special attention was given to the potentially confounding effects of inventory and sales cycles. Inventory was found to have no significant effect on the playing of the game other than that occurring through scarcity or oversupply. In other words, there was no inventory cycle. The cyclical effect of sales normally part of the game was removed and a constant growth rate of four percent per quarter was substituted.

Value of the study

This study has certain realistic and theoretical values. The use of a realistic decision making situation was intended to help bridge the gap between theory and application. It was hoped that the use of the business simulation game as the medium for studying the Mach variable would provide a more realistic base for possible application in general management practices. The theoretical value centers around the further testing of the Mach concept and the extension of this concept to include the group. Further, the combination of Mach theory with task and social leadership theories has produced some interesting results.

The Mach syndrome is a collection of personality and situational variables directly concerned with manipulation. Applied to the group, the high Mach emerges as the compulsive manipulator primarily concerned with task achievement and the satisfaction of the task needs of the group. On the other hand, the low Mach emerges as the social leader primarily concerned with the social needs of the group. The Mach concept was previously applied to individual interaction apart from the group. The contribution of this study to theory is primarily in the extension of Mach theory to include the group and its modification to incorporate the theories of leading group theorists such as Bales and Borgatta.

Further value can be found in this study's longitudinal characteristic. The introduction of the element of time permits the sequential analysis of the behavior of the various groupings. Such an analysis makes possible the study of the key situational variable of uncertainty. The Mach concept can be studied in terms of competition, group structure and composition and the effects of change of leadership. The effect of these various factors on group productivity is also an important contribution.

Suggestions for future research

There are several areas of potentially valuable future research. Some valuable insights could be provided from a study of the member satisfaction of the various groupings. The theoretical implication of Bales and Borgatta theories implying that the presence of both task and social leadership results in the satisfaction of more of the member's needs should be tested. If greater satisfaction is found among the members of heterogeneous groups additional support for the relationship of employee satisfaction and increased productivity would be had.

Future research should be done to determine the relationship of irrelevant affect and the anxiety levels of the individual. The resistance of the high Mach to irrelevant affect may be explainable in terms of his low level of

anxiety.

The number of trials used in future research should be extended in order to determine if the reduction or elimination of productivity differences can be explained in terms of random changes in the productivity functions. Such research could also establish if the high Mach is more efficient in periods of rapid change because of his ability to withstand the effects of this change but less efficient in a situation where structure and routine replaces the unstructured situation. Such information would be of great value in the coordination of group structure and environment to encourage greater productivity.

Requests for help were found to be more frequent from low Mach homogeneous groups. Future study should investigate the relationship of low Machs and their dependency needs and the high Machs and their autonomy needs.

Another study might be done to assess the effects of long periods of success and failure on the different groupings. It might be argued that the heterogeneous grouping would be more stable in that it satisfies more of the group's needs.

The relationship between the persuasiveness of the high Mach and his ability to resist persuasion and the trait of self confidence should be explored. Gibb in an early article found a positive correlation of 0.60 between inter-

viewer ratings of self confidence and ultimate choice for leadership positions. The high Mach's ability to persuade and inability to be persuaded could be perceived as self confidence. This relationship is given support by the research finding that the high Mach is generally chosen to lead the group.[109] Another trait whose relationship to Mach should also be studied is the presence or absence of anxious worrying. Cattell and Stice found in their research that the absence of anxious worrying successfully differentiated between leaders and non leaders. The theorized "coolness" of the Mach could be variously described as the absence of anxious worrying.

Summary

Christie and Geis' Mach theory was extended to include the group situation. The analysis of the competitive relationship of high and low Mach groups yielded support for a comparative advantage for the high Mach groups. Attempts to measure the contribution of the Mach of the leaders and followers to group productivity did not yield significant results but were in the predicted direction.

Attempts to analyze the key situational variable of uncertainty did not yield significance but were in the predicted direction. Time was found to be an intervening variable directly affecting the achievement of significance.

Further studies should consider the time variable.

The composition of groups was varied by exchanging leadership. The resulting composition of groups produced two general categories entitled homogeneous and heterogeneous. Heterogeneous groups were composed of both high and low Mach members. High and low Machs were related to task and social leaders and it was hypothesized that the groups containing both high and low Machs satisfied more of the group's needs and were, therefore, more productive. This contention received significant support.

The limitations of the study were discussed with special attention being given to the limitations of inadequate financing. Finally, future research was proposed and the relative newness of the concept and its need for research was cited.

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Appendix A

You will find 20 groups of statements listed below. Each group is composed of three statements. Each statement refers to a way of thinking about people or things in general. They reflect opinions and not matters of fact -- there are no "right or wrong" answers and different people have been found to agree with different statements.

Please read each of the three statements in each group. Then decide first which of the statements is most true or comes the closest to describing your own beliefs. Circle a plus (+) in the space provided on the answer sheet.

Just decide which of the remaining two statements is most false or is the farthest from your own beliefs. Circle the minus (-) in the space provided on the answer sheet.

Here is an example:

	Most True	Most False
A. It is easy to persuade people but hard to them persuaded.	+	-
B. Theories that run counter to common sense are a waste of time.	(+)	-
C. It is only common sense to go along with what other people are doing and not be too different.	+	(-)

In this case, statement B would be the one you believe in most strongly and A and C would be ones that are not as characteristic of your opinion. Statement C would be the one you believe in least strongly and is least characteristic of your beliefs.

You will find some of the choices easy to make; others will be quite difficult. Do not fail to make a choice no matter how hard it may be. You will mark two statements in each group of three-the one that comes the closest to your own beliefs with a + and the one farthest from your beliefs with a -. The remaining statement should be left unmarked.

Do not omit any groups of statements.

1. A. It takes more imagination to be a successful criminal than a successful businessman.
   B. The phrase, "the road to hell is paved with good intentions" contains a lot of truth.
   C. Most men forget more easily the death of their

father than the loss of their property.

2. A. Men are more concerned with the car they drive than with the clothes their wives wear.
   B. It is very important that imagination and creativity in children be cultivated.
   C. People suffering from incurable diseases should have the choice of being put painlessly to death.

3. A. Never tell anyone the real reason you did something unless it is useful to do so.
   B. The well-being of the individual is the goal that should be worked for before anything else.
   C. Once a truly intelligent person makes up his mind about the answer to a problem he rarely continues to think about it.

4. A. People are getting so lazy and self-indulgent that it is bad for our country.
   B. The best way to handle people is to tell them what they want to hear.
   C. It would be a good thing if people were kinder to others less fortunate than themselves.

5. A. Most people are basically good and kind.
   B. The best criteria for a wife or husband is compatibility -- other characteristics are nice but not essential.
   C. Only after a man has gotten what he wants from life should he concern himself with the injustices in the world.

6. A. Most people who get ahead in the world lead clean, moral lives.
   B. Any man worth his salt shouldn't be blamed for putting his career above his family.
   C. People would be better off if they were concerned less with how to do things and more with what to do.

7. A. A good teacher is one who points out unanswered questions rather than gives explicit answers.
   B. When you ask someone to do something for you, it is best to give the real reasons for wanting it rather than giving reasons which might carry more weight.
   C. A person's job is the best single guide as to the sort of person he is.

8. A. The construction of such monumental works as the Egyptian pyramids was worth the enslavement of the workers who built them.
   B. Once a way of handling problems has been worked out it is best to stick to it.
   C. One should take action only when sure that it is morally right.

9. A. The world would be a much better place to live in if people would let the future take care of itself and concern themselves only with enjoying the present.
   B. It is wise to flatter important people.
   C. Once a decision has been made, it is best to keep changing it as new circumstances arise.

10. A. It is a good policy to act as if you are doing the things you do because you have no other choice.
    B. The biggest difference between most criminals and other people is that criminals are stupid enough to get caught.
    C. Even the most hardened and vicious criminal has a spark of decency somewhere within him.

11. A. All in all, it is better to be humble and honest than to be important and dishonest.
    B. A man who is able and willing to work hard has a good chance of succeeding in whatever he wants to do.
    C. If a thing does not help us in our daily lives, it isn't very important.

12. A. A person shouldn't be punished for breaking a law which he thinks is unreasonable.
    B. Too many criminals are not punished for their crime.
    C. There is no excuse for lying to someone else.

13. A. Generally speaking, men won't work hard unless they're forced to do so.
    B. Every person is entitled to a second chance, even after he commits a serious mistake.
    C. People who can't make up their minds aren't worth bothering about.

14. A. A man's first responsibility is to his wife, not his mother.
    B. Most men are brave.
    C. It's best to pick friends that are intellectually stimulating.rather than ones it is comfortable to be around.

15. A. There are very few people in the world worth concerning oneself about.
    B. It is hard to get ahead without cutting corners here and there.
    C. A capable person motivated for his own gain is more useful to society than a well-meaning but ineffective one.

16. A. It is best to give others the impression that you can change your mind easily.
    B. It is a good working policy to keep on good terms with everyone.
    C. Honesty is the best policy in all cases.

17. A. It is possible to be good in all respects.
    B. To help oneself is good; to help others even better.
    C. War and threats of war are unchangeable facts of human life.

18. A. Barnum was probably right when he said that there's at least one sucker born every minute.
    B. Life is pretty dull unless one deliberately stirs up some excitement.
    C. Most people would be better off if they controlled their emotions.

19. A. Sensitivity to the feelings of others is worth more than poise in social situations.
    B. The ideal society is one where everybody knows his place and accepts it.
    C. It is safest to assume that all people have a vicious streak and it will come out when they are given a chance.

20. A. People who talk about abstract problems usually don't know what they are talking about.
    B. Anyone who completely trusts anyone else is asking for trouble.
    C. It is essential for the functioning of a democracy that everyone votes.

Appendix B

PENALTIES

Each team is required to be present in its entirity for the start of every decision trial. If for some reason a member or team is unable to be present for the start of a trial, it is the responsibility of the team leader to notify me or one of the two moderators in advance and to schedule the trial for another period during the day, that night, or the following day before 3:00 P.M. Failure to notify in advance will be reflected in the team's and member's grades.

No team member is allowed to leave the decision room prior to the completion of the period without the consent of myself or one of the student moderators. Only the team leader is allowed to ask questions concerning the game and these questions will be directed to me.

Any evidence of collusion among teams will serve to disqualify those teams from further competition and will result in an automatic "F" for the course.

All teams and their members are expected to act in a professional manner when engaged in the decision making trials. This behavior should be extended to include the individual presentation to be made at the end of the game.

Appendix C.

To: Computer Game Participants

From: Professor L. Desfosses

Subject: Evaluation of Teams

Each team will be evaluated with respect to its ratio of profits to assets. Profits is defined as the excess of revenue over costs. Profit for each company is listed in the decisions results section of the team's results as given by the computer after each decision period. Assets is defined as the Cash, Accounts Receivable, Material Inventory, Product Inventory, and Plant & Equipment. The balances of these accounts is also given to each team by the computer.

Again, the ratio by which each team is to be evaluated is:

$$\frac{\text{Profits}}{\text{Total Assets}}$$

Appendix D

FORECAST

The forecast for all trial periods will reflect a constant growth rate of four percent. Therefore, in the blocks on the decision form designated FCST, the student will enter the figure 104. This figure reflects 100 percent of the previous forecast plus a 4 percent growth.

Appendix E

The Jonckheere test was used in this study to determine whether rank order of differences in productivity between high and low Mach groupings was significant.

In order to determine the significance of the observed ranked differences, it is first necessary to compute the Kendall S coefficient.

$$\text{Let } p_{ij} = \sum_{\alpha_{i=1}}^{m_i} \sum_{\alpha_{j=1}}^{m_j} pi\alpha_i\alpha_j$$

$$\text{and finally, let } S = 2 \sum_{i=1}^{k-1} \sum_{j=1+i}^{k} p_{ij} - \sum_{i=1}^{k-1} \sum_{j=1+i} m_i m_j \qquad (1)$$

where: $p_{ij} = p_{12}, p_{13}, p_{1n}, p_{nn}$

m_i = number of samples

m_j = number in each sample

Once the S coefficient has been determined it can be converted into a coefficient more easily translated in terms of its significance. This coefficient is the Z coefficient.

$$\text{Let } Z = \frac{S}{\sqrt{\frac{1}{18}[\{n^2(2n+3) - \sum_{r=1}^{k} m_4^2(2m_r+3)\}]}} \qquad (2)$$

where: n = number of sample points (i.e., group scores).

m_r = number of groups in a sample.

An example of the aforementioned analysis is now presented for the purpose of illustration.

I	II	III	IV
19	21	40	49
20	61	99	110
60	80	100	151
130	129	149	160

$m_1 = m_2 = m_3 = m_4 = 4$ $k = 4$ $p_{12} = 11$, $p_{13} = 12$, $p_{14} = 13$,

$p_{23} = 11$, $p_{24} = 12$, $p_{34} = 12$

Therefore using (1) $S = 2 \times 71 - 96 = 46$

using (2)
$$\frac{46}{\sqrt{\frac{1}{18}[\{16^2(2(16) + 3) - \sum_{1}^{4} 4_r^2 (2(4_r) + 3)\}]}}$$

$$\frac{46}{\sqrt{\frac{1}{18}[\{6400 - 704\}]}}$$

$$\frac{46}{17.76} = 2.58$$

2.58 significant at greater than the .01 level.